

## Asia 2015 6<sup>th</sup> - 8<sup>th</sup> of Jul

AUTOMOTIVE LIGHTWEIGHT

# PROCUREMENT SYMPOSIUM

Jumeirah Himalayas Hotel in Shanghai, China



### SYMPOSIUM FOCUS

- Aluminium
- Carbon Fibre
- Composites
- High Strength Steel
- Magnesium

## HIGHLIGHTS

### • INTERNATIONAL SPEAKERS

AUDI - MAGNA - DGS - GEELY - NOVELIS - JSC - VOESTALPINE, ...

### • LIGHTWEIGHT TECHNOLOGY EXHIBITION

DGS - StrikoWestofen - Kurtz - Novelis – Idra

### • SIMULTANEOUS INTERPRETING

Chinese - English / English - Chinese

### ATTENDING COMPANIES



### MEDIA & ORGANIZATION PARTNERS



Brings together the procurement and supply side of lightweight materials and their advanced processes in accompany with cost balance or reduction....

## AluMag® offers the four following services - worldwide:



Market Research

- Aluminium Extrusion Customer Database
- Foundry & Tool Maker Database
- Automotive Application, Material & Process Analyses
- Various Industrial Application Research & Analyses

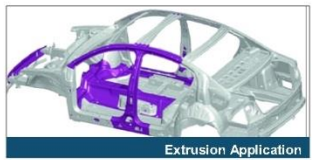
AluMag as your provider of automotive research and forecasting studies, offers you and your business, the market intelligence you need to realize the best strategic decisions



Material - Process - Application Trend Analysis

### Large variety of market access, local & global:

- business database with 6,970+ companies and 18,700+ contacts
- 150+ satisfied customers worldwide
- Arranged 20+ roadshows/events since 2008



Extrusion Application

### Your Benefits:

- Learn about your [potential] clients and competitors
- Obtain an inside view of the market
- Identify opportunities and threats
- Minimize risk and optimize profits
- Position your company successfully
- Based on data off the shelf, secondary re-search and interviews, AluMag generates validated researches



Market Development

- Analysis & Development of Market Opportunities
- Accelerate Market Penetration
- Manage New Product Launches
- Establish a Sales Force Sales on Demand

AluMag guides and supports your organization globally through the different market development phases until we have successfully launched, implemented or executed your project.



Map of activity - SAMPLES

Manage and integrate each aspect of your organization by initiating, planning, controlling, executing and closing out a new project. AluMag offers liaison management services as an addition to our customer's staff by bringing in the resources that define us.



JATCO Head Quarters Meeting in Japan

### Your Benefits

- Analysis and development of Markets
- Realize opportunities
- Accelerate market penetration
- Establish a sales force
- Provide warehousing and distribution services
- Manage new product launches
- Sales on demand



Roadshows / Events

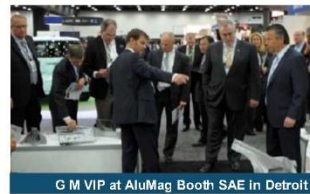
- Organization of Technical & Commercial Roadshows
- Oversea Commercial & Technical Events
- Host In-House Events & Presentation
- Common Technology Booth at Leading Exhibitions

AluMag roadshows, tech-meetings and symposia are the first class events used by exhibitors and guest as a unique benchmark platform.



Daimler Sindelfingen as Roadshow Location

The AluMag think tank events are bringing in decision makers and executives in EUROPE, ASIA and NAFTA.



G M VIP at AluMag Booth SAE in Detroit

### Upcoming Events:

- 2015 Jul: Automotive Light-weight Procurement Symposium in Shanghai, China
- 2015 Nov: Automotive Light-weight Procurement Symposium in Detroit, USA
- 2016 April Common tech- booth at the SAE World Congress in Detroit, USA
- 2016 Jul: Automotive Light-weight Procurement Symposium in Shanghai, China



Strategic Localization

- Warehousing & Distribution Service
- Supplier & Tie-up Localization
- Identification & Trade-off of new Technology
- Foreign Market Business Cases and whose Realization

AluMag has the global expertise to search, identify, evaluate and validate potential strategic business opportunities for expansions and partnerships that will assist your business growth plans regionally and globally



On-Site Greenfield Planning Meeting

### Services for:

- Search, develop and present potential acquisition candidates for regional and global business expansions
- Localization of new manufacturing / service sites for business expansions
- Identification of new technology supplier development related to products, processes and materials
- Search, develop and present potential business partners / suppliers to support regional and/or global supply programs
- Evaluate potential competitor profiles for new or existing business in non-presence geographies
- Evaluate new emerging technologies and processes for business expansions

### Are you:

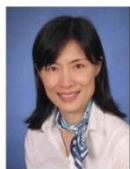
- looking for specific data, information and outlook about product, material, customer, supplier, technologies, ...
- want to discuss your project, increase sales, access new markets, ...
- interested to participate in one of our roadshows / events or organize your customized showcase ...
- looking to localize, expand into new markets, countries, tie-up targets, ...

**please contact your AluMag Team to receive a quote or proposal**

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**Asia Automotive Lightweight Procurement Symposium**  
**6th – 8th of July 2015**  
Jumeirah Himalayas Hotel in Shanghai, China.



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**AluMag®**  
Europe ■ India ■ Americas ■ Asia  
**THE MARKET DEVELOPER**

## Company Speechs by:

<u>Audi AG</u>	<u>10</u>
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# Agenda

## Agenda: (Is Continuously Being Updated)

### Monday The 6th Of July – Jumeirah Himalayas Hotel, Shanghai – 6th Floor

06:00pm - 10:00pm

Pre-registration and Welcome Reception

### Tuesday The 7th Of July – Jumeirah Himalayas Hotel, Shanghai – 6th Floor

08:30am – 09:15am

Registration & Morning Coffee / Tea

09:15am – 09:30am

Welcome:

Mr. Jost GAERTNER, Managing Partner at ALUMAG Automotive GmbH

09:30am – 10:25am

Opening Keynote:

Mr. Frank VENIER, Strategy and Innovation; Lightweight Design Centre at AUDI AG

**Lightweighting SUV - The New Audi Q7 In Multimaterial Car Body Design**

10:25am – 11:00am

Break for Refreshments/Coffee/Tea, Snacks, Networking, Tech Exhibition

11:00am – 12:00am

Paper 1 – Part 1:

Mr. Gerhard KRACHLER, Director Advanced Development & Product Strategy at MAGNA STEYR Engineering AG & Co.KG

Paper 1 – Part 2:

Mr. Christian JURICEK, Manager R&D Europe at COSMA MAGNA International

**Magna's Global Advanced Lightweight Competences**

12:00pm – 01:45pm

Break for Refreshments/Coffee/Tea, Lunch, Networking, Tech Exhibition

01:45pm – 02:25pm

Paper 2:

Mr. Andreas MUELLER, CEO at DGS Druckguss Systeme AG

**Localization And Industrialization Of Cast Aluminium Structural Applications**

02:30pm – 03:10pm

Paper 3:

Mr. Li WAN, Vice President at Guangdong Hongtu Technology (Holdings) Co Ltd

**Aluminum Alloy High Vacuum Die Casting Technology And It's Application On Automotive Structural Parts**

03:15pm – 03:45pm

Paper 4:

Mr. Lothar HARTMANN – Managing Director Foundry Machines & Trimming Presses at Kurtz GmbH

Mr. Michael BARTEL – Asia Sales Manager Foundry Machines & Trimming Presses – Kurtz GmbH

Low Pressure Casting

A traditional casting technology helping to step ahead for light weight solutions in engine block manufacturing

03:45pm – 04:15pm

Break for Refreshments/Coffee/Tea, Snacks, Networking, Tech Exhibition

04:15pm – 04:55pm

Paper 5:

Mr. Peter BERNSCHER, Member Of The Board & Director Automotive Body Parts at Voestalpine Metal Forming GmbH

**Lightweight Solutions In The Automotive Industry By Voestalpine**

05:00pm – 05:55pm

Closing Keynote:

Mr. Jochen SIEBERT, Managing Partner at JSC Automotive Consulting Co. Ltd.

**Outlook And Hurdles Of The Chinese Economy And Automotive Industry**

05:55pm – 06:00pm

Summary:

Ms. Ying ZHOU, Project Coordinator China – Japan at ALUMAG Automotive GmbH

06:00pm - 10:00pm

Reception Sponsored By StrikoWestofen

Dinner Speech – Part 1:

Mr. Rudolf RIEDEL – Group Managing Director at StrikoWestofen GmbH

Dinner Speech – Part 2:

Mr. Rainer ERDMANN – Managing Director Asia Operations at StrikoWestofen Thermal Equipment Co.Ltd

**Profits With Light Metal Castings Start In The Melt Shop**

# Agenda

## Agenda: (Is Continuously Being Updated)

### Wednesday The 8th Of July

08:15am – 08:55am

Opening Keynote:

Prof. Fei XIONG Chief Engineer & Director of Auto Lightweight Department at GEELY

#### **Automotive Lightweight Promoting The Application Of Aluminium**

09:00am – 09:40am

Paper 1:

Mr. James LIU, Managing Director and Vice President of Asia Auto at NOVELIS China

#### **High Volume Aluminum Solutions For Lightweighting**

09:45am – 10:25am

Paper 2:

Dr. Jin HOU – General Manager – Sapa Technology Asia

#### **High Performance Aluminium Alloys For Automotive Light-Weighting**

10:25am – 11:00am

Break for Refreshments/Coffee/Tea, Snacks, Networking, Tech Exhibition

11:00am – 11:40am

Paper 3:

Mr. Yoshikazu MUKAI, Executive Vice President & Technical Specialist at Kobelco Automotive Aluminium Rolled Products (China) Co.,Ltd – Shanghai Branch

#### **Kobe's R&D Activities For Automobile Lightweighting**

11:45am – 12:25pm

Closing Keynote:

Mr. Martin SHI, Chief Editor at GASGOO International And Senior Analyst at GASGOO Research Institute

#### **The Status And Development Trends Of China Automobile Lightweight**

12:30pm – 12:35pm

Summary:

Mr. Jost GAERTNER, Managing Partner at ALUMAG Automotive GmbH

12:45pm – 01:00pm

Walk To The SNIEC  
Shanghai New International Expo Centre

01:00pm – 01:40pm

Reception With  
Snacks & Finger Food at the SNIEC

01:40pm – 05:30pm

Individual Or Guided Visit At The 2015 "Aluminium China " And "China Diecasting" Exhibitions

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Backup Speech

Mr. Jost GAERTNER, Managing Partner at AluMag Automotive GmbH

#### **Top 16 Global Ranking Of Aluminium And Magnesium Foundries By Revenue**

# EXHIBITOR

**DGS Druckguss Systeme AG**  
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## **TITLE**

**Lightweighting SUV – The New Audi Q7 In Multimaterial Car Body Design**

## **ABSTRACT**

Abstact not available.



Shanghai 2015



**Lightweighting SUV**  
**The New Audi Q7 in**  
**Multimaterial**  
**Car Body Design**

Dr. Bernd Mlekusch

Frank Venier

Folgende Bilder von der Webseite >>> [http://www.caricos.com/cars/a/audi/2016\\_audi\\_q7/1024x768/96.html](http://www.caricos.com/cars/a/audi/2016_audi_q7/1024x768/96.html)

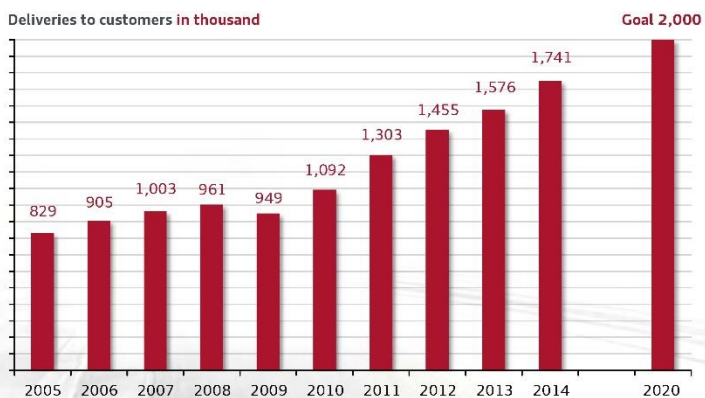


## Agenda

- **Automotive Trends**
- Audi solutions
- Comparison of Body Materials
- Challenge Multimaterial-mix
- Implementation
- Summary



## Automotive Trends Corporate Strategy 2020 of AUDI



- ▶ **Goal:** To be the world's leading brand in the premium automobile segment.
- ▶ **How:** By consistently pursuing our product initiative and targeting higher market shares.

3



## Automotive Trends Trends for automotive industry

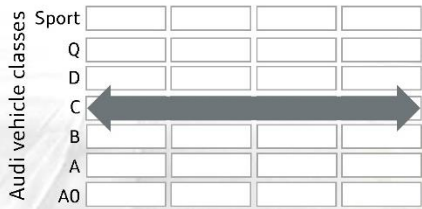
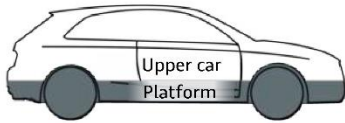
- ▶ Regulations
- ▶ Electrification
- ▶ Individualization
- ▶ Connected Car
- ▶ ...





## Audi solutions Modular Systems

### Platform strategy:

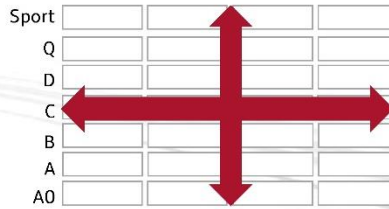
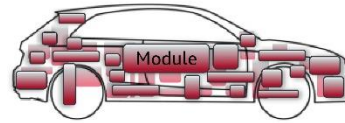


Car body from



Synergies within similar vehicle classes

### Module-system strategy:



Car body form

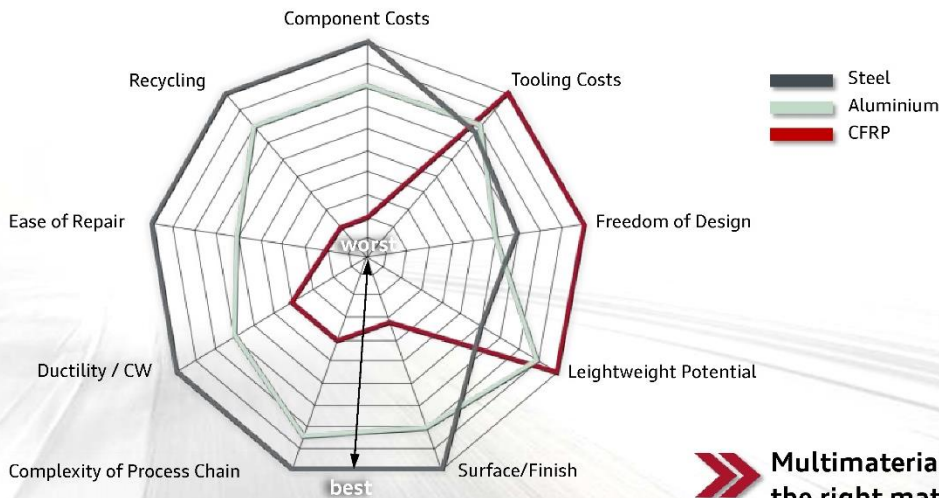


Synergies completely encompassing all vehicle classes

5



## Comparison of Body Materials Qualitative Properties

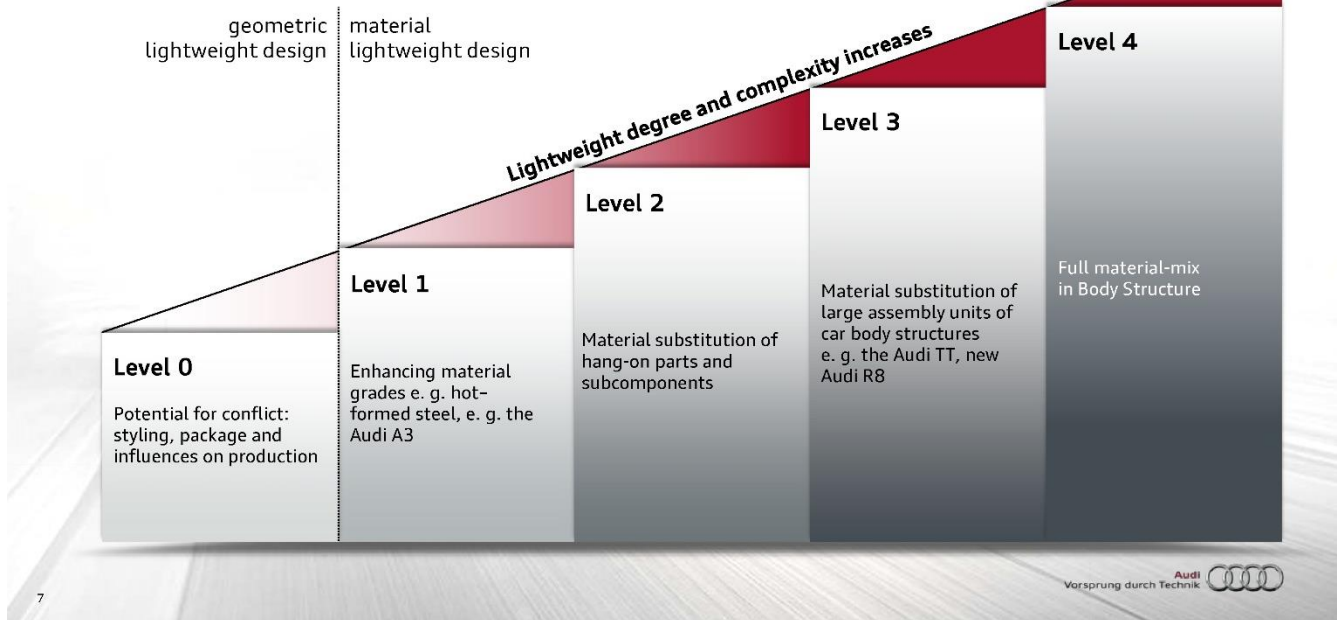


Multimaterial-mix:  
the right material at the right place

6



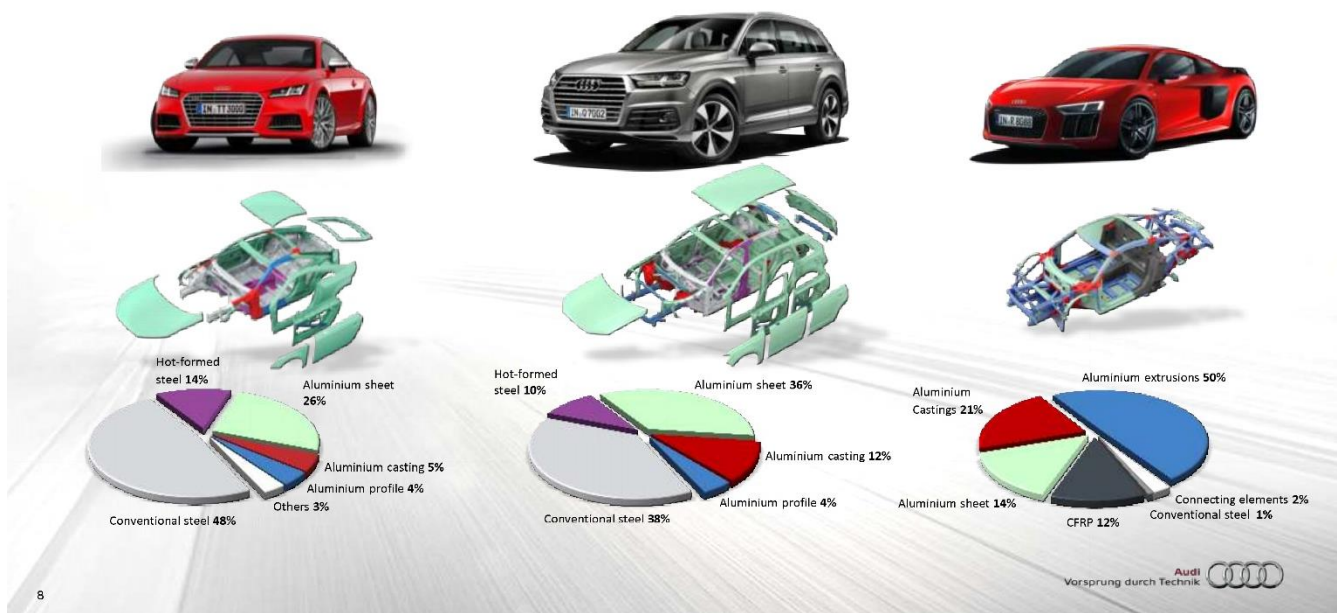
## Challenge Multimaterial-mix Lightweight Design: approach in different steps



7



## Summary Multimaterial-mix in different Car-Bodys



8



**Mr. Gerhard Krachler**  
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## **TITLE**

### **Magna's Global Advanced Lightweight Competences**

## **ABSTRACT**

#### 1) Introduction

With all the statutory requirements to reduce CO2 emissions, the lightweight approach becomes more important than ever. Besides downsizing, lightweight design is one of the key factors to improve vehicle emissions.

#### 2) Lightweight with major impact on new vehicle requirements

Intelligent lightweight design comprises the integration of functions, downsizing and innovative multi-material-mix.

The cost reduction as a result of 'functional integration' and 'downsizing' leads to a partial compensation of the additional cost resulting from the substitution of materials. Integration of functions means that every part has to fulfill as many functions as possible in order to reduce the number of parts.

Downsizing and exploitation of secondary effects express the idea that a vehicle that is significantly lighter will need smaller, lighter and cheaper components which satisfy the same functional requirements. For example, such a lightweight car needs smaller brakes for the same braking distance, or the powertrain delivers the same performance even if the cubic capacity and the number of cylinders are reduced.

#### 3) Virtual development

Innovative lightweight vehicle concepts have to be designed in such a way to meet the requirements in terms of crash, acoustics, structural durability and stiffness.

Lightweight materials in general have a lower ductility compared to steel. This in turn requires new strategies in terms of passive safety – in particular the conversion of kinetic crash energy into deformation energy. The basic approach implies the definition of deformation zones, allowing energy absorption through fragmentation of material, as well as zones with guaranteed structural integrity.

#### 4) Eco Design – Life Cycle Analysis and Total Costs of Ownership

"Eco-design", "design for the environment", "life cycle design" or "design for sustainability" is defined as: "systematic consideration, during new product and process development, of design issues associated with environmental and human health and safety over the full product life-cycle".

This is especially important for innovative lightweight concepts since they require the application of new materials and the development of new processes.



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# Magna Steyr Engineering AG & Co KG

## Magna's Global Advanced Lightweight Competences

Gerhard Krachler  
Magna Steyr Engineering

Christian Juricek  
Magna Cosma International

Asia Automotive Lightweight Symposium  
6<sup>th</sup> – 8<sup>th</sup> of July, Shanghai - China



### Our Global Presence



~133,000 People

29 Countries

● 316 ● 87

\$36.6 Billion  
(2014 Sales)

- Manufacturing / Assembly
- Engineering / Product Development / Sales
- Number of Employees

Q1 2015

# Magna Steyr Engineering AG & Co KG

## Our Global Capabilities



## Our Product Systems





# Magna Steyr Engineering AG & Co KG

## Structure of MAGNA International



## Magna Steyr Range of Services



Flexible and global solutions customized for the OEM

### Engineering

From systems and modules to complete vehicle engineering

### Contract Manufacturing

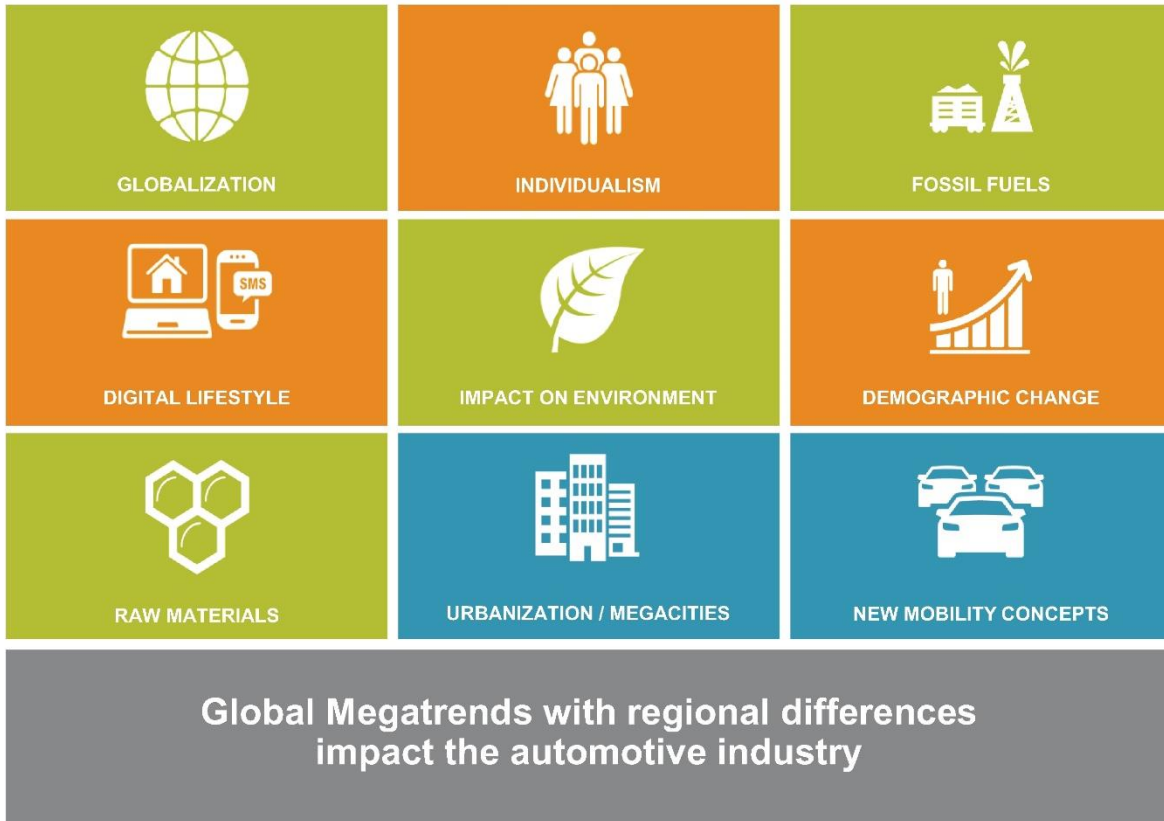
World Class flexible solutions from niche to volume production

### Fuel Systems

Energy storage systems made of steel, plastic and aluminum

# Magna Steyr Engineering AG & Co KG

## Global megatrends Drivers of New Technologies



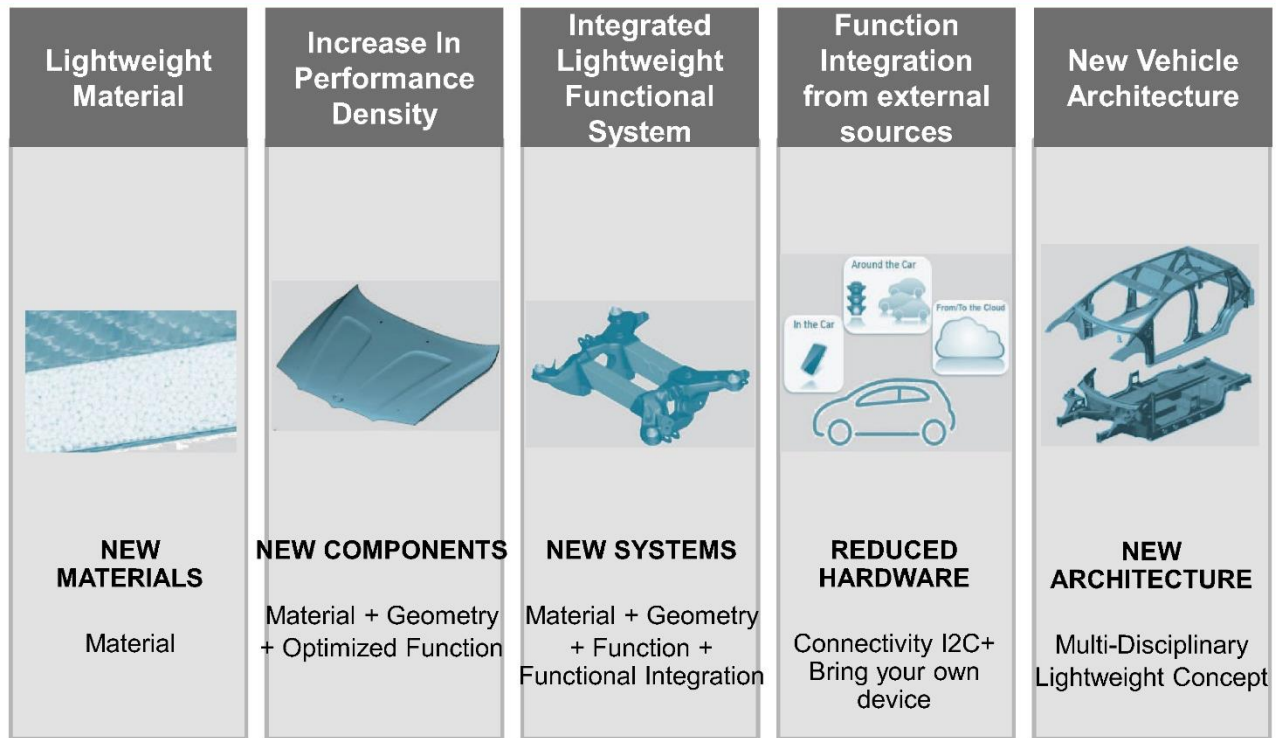
## Magna Innovation Pillars



 <b>SMARTER</b> Comfort, Convenience and Connectivity	 <b>CLEANER</b> Efficiency and Sustainability	 <b>SAFER</b> Active and Passive Safety	 <b>LIGHTER</b> Lightweight Material and Science
 for future HMI demand, interior concepts will be completely changed	<p style="text-align: center;">Global Legislation – CO<sub>2</sub> Fleet Emission Targets</p> <p style="text-align: center;">lots of different legislation targets lead to different approaches</p>	 Advanced Driver Assistance Systems (ADAS) enable semi autonomous driving	 improve driving performance, CO <sub>2</sub> & fuel economy, Total Cost of Ownership (TCO)
 <b>AFFORDABLE</b> Development and Manufacturing Efficiency			

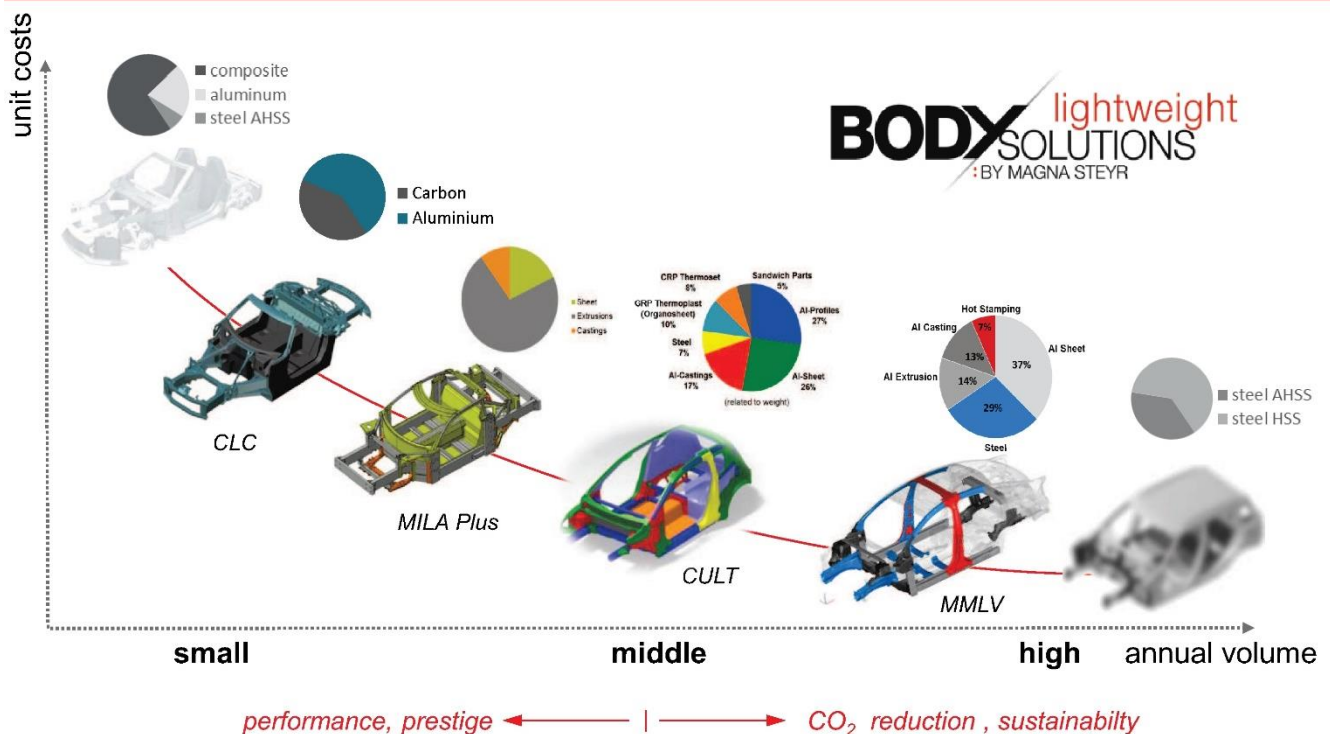
# Magna Steyr Engineering AG & Co KG

## Different approaches driving weight reduction



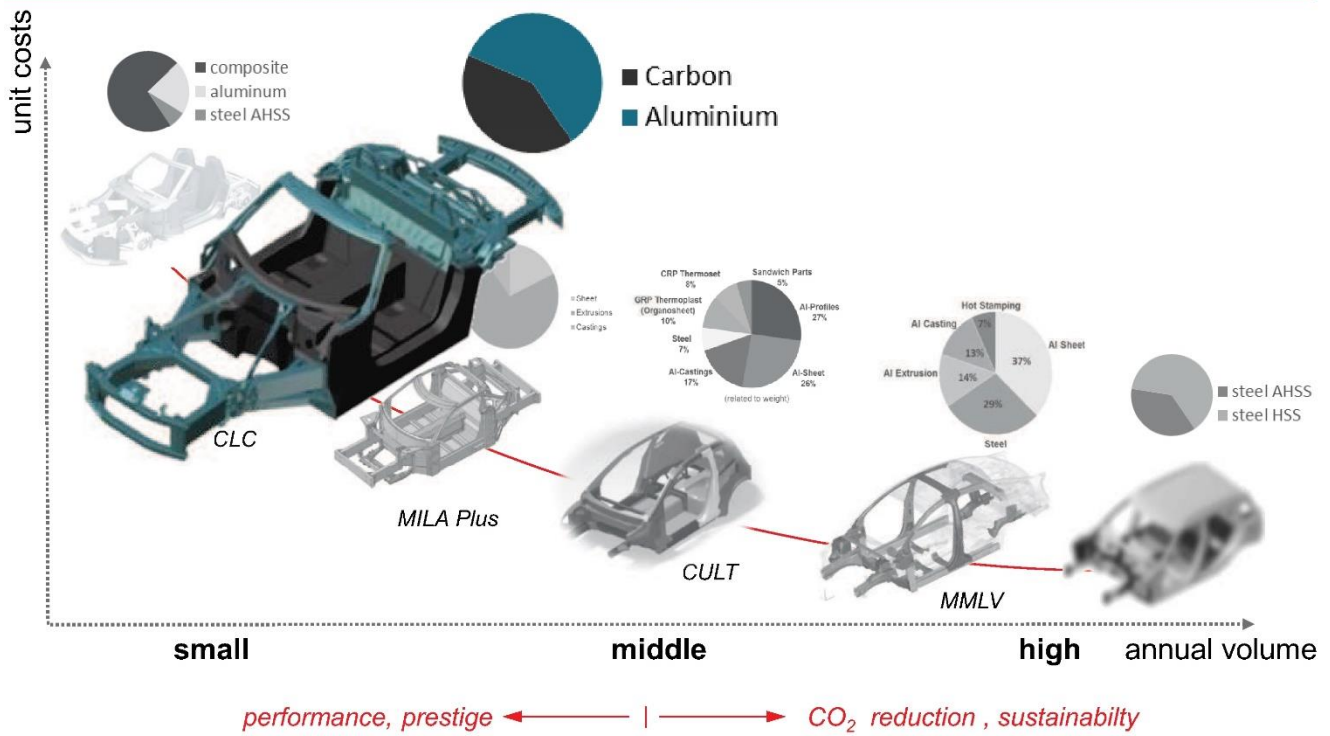
Only a unified approach will drive towards a significant weight reduction

## Lightweight concepts overview



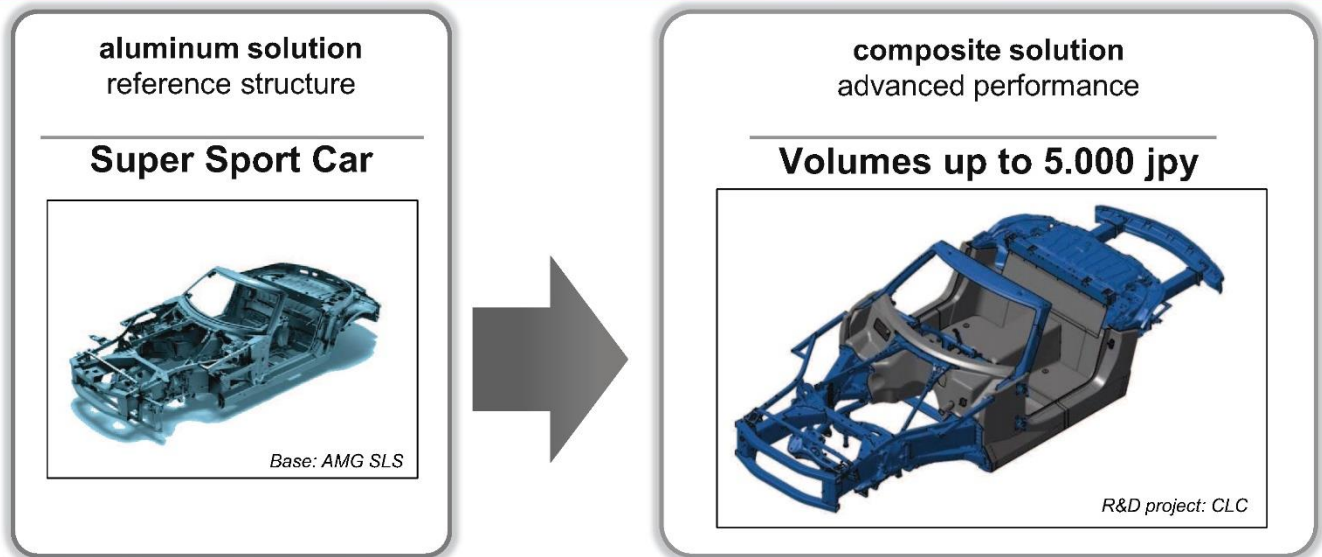
Innovative lightweight body design from performance to sustainability driven segments

## CLC (Composite Life Cell)



Carbon fibre composite solution for better cost efficiency

## CLC Motivation



### Targets in comparison to reference structure:

- increase torsional stiffness about 10 %
- reduce weight of passenger cell about 20 %
- comparable crash performance
- reference cost + 80 €/kg

Qualified virtual development and production integration of composite structures.

## CLC Details



### CFRP Structure Design

- ✓ Composite specific design
- ✓ Design for manufacturing
- ✓ Strength and stiffness calc.
- ✓ Insert design

### PT assembly/Test

- ✓ Clearance of layup, reference point for prototype assembly
- ✓ Prototype assembly
- ✓ NVH tests

Bending tests with sidewall/rocker:

- ✓ pole crash test
- ✓ test validation

### Production Concept

CLC body structure

Body in White

Body in Black

- ✓ CFRP cell production
- ✓ Al front/rear structure production (analog SLS)
- ✓ BIW framing (e-coated and sealed AL front/rear structure)
- ✓ Calculation of production and part costs (outer panel: e.g. low temperature 80° paint process)

From CFRP optimized part design up to suitable production concept

## CLC Virtual Development



### CAD and CAE Model Build-Up

**Implemented**

- ✓ Draping characterization/ simulation
- ✓ CAD-CAE exchange process
- ✓ Fiber direction mapping
- ✓ Model guide line CAD-CAE
- ✓ FRP design process

### Structural Durability

**Implemented**

- ✓ Ply modeling
- ✓ Failure criteria
- ✓ Stiffness prediction
- ✓ Joint optimization
- ✓ Optimization methods

### Acoustics and Vibration

**Implemented**

- ✓ Mat. Characterization
- ✓ Sim. Model setup
- ✓ Sound transmission test
- ✓ Sound transfer test
- ✓ Influence analysis of production analysis
- ✓ Validation of simulation

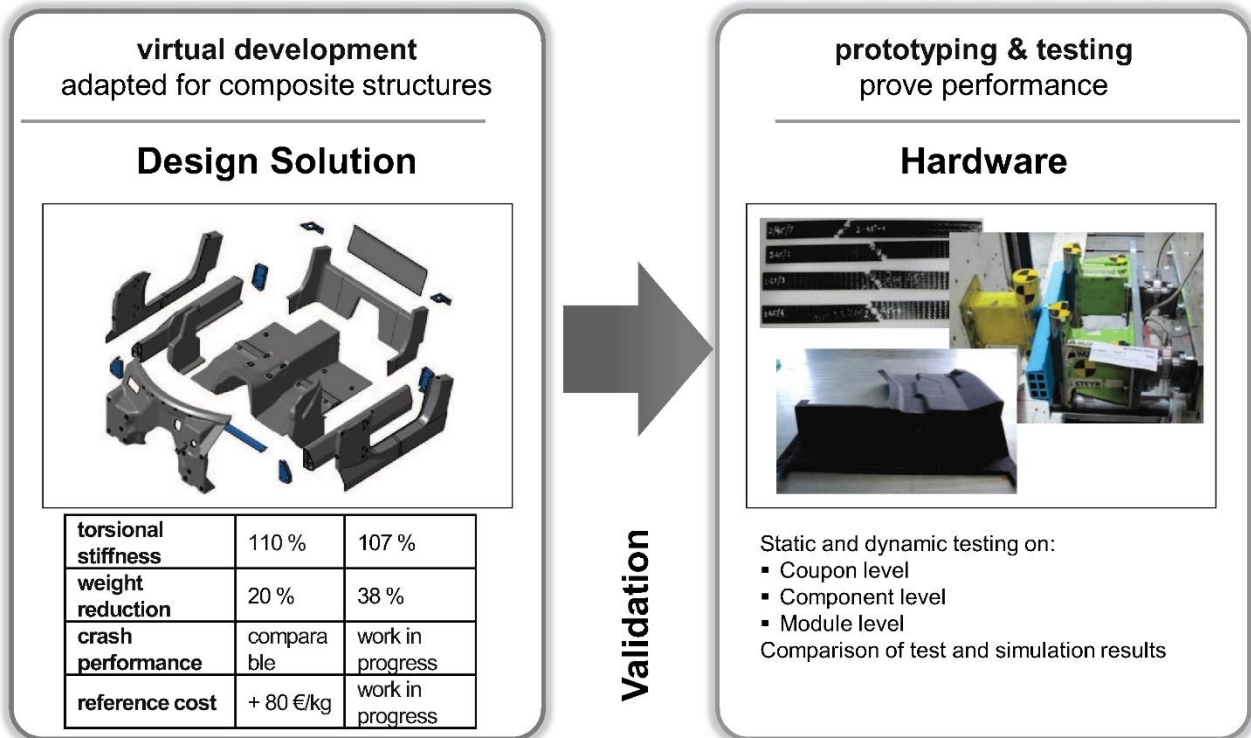
### Vehicle Safety

**Implemented**

- ✓ Ply and foam modeling
- ✓ Material characterization
- ✓ Validation part/system level
- ✓ Testing
- ✓ Increase numeric stability

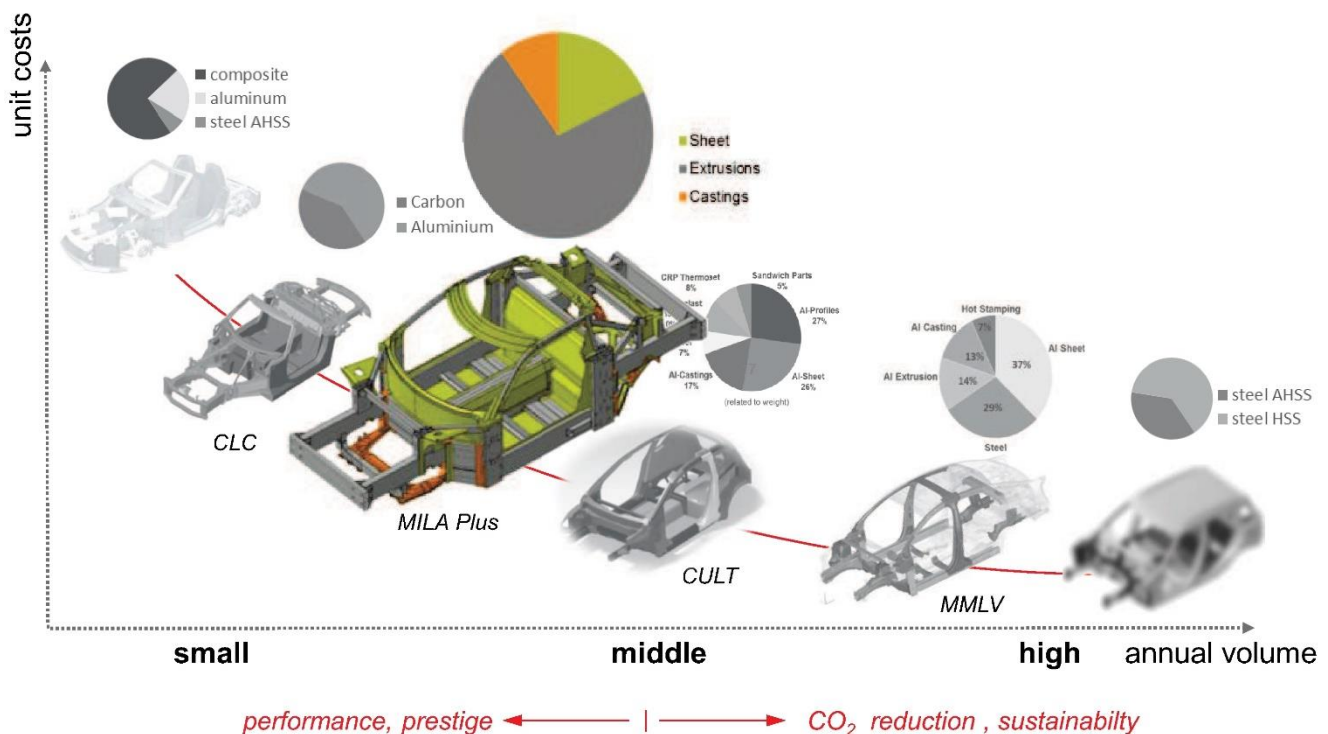
Validated virtual methods save development time and prototype costs

## CLC development



Design related hardware for performance testing

## MILA Plus



Advanced spcaeframe concept for low volumes

## Mila Plus Architecture



- Affordable lightweight concept for small volumes
- One scalable aluminum body structure design for several customers with full differentiation in upperbody, powertrain and chassis.
- Scalable body performance (Weight, Stiffness, Safety) with variably profile inner Cross-section
- Different upperbody, powertrain and chassis layouts considered
- ~35% saving costs compared to stand-alone platform
- ~20% saving costs compared to stand-alone complete body
- Minimized invest for cost efficient production (“economy of scale”)
- Reduced time to market regarding practical experience and confirmed solutions in lightweight design
- Virtual development and simulation of concepts: Structure Stiffness & Durability, Vehicle Safety



### BIW Architecture: profil intensive aluminium spaceframe design

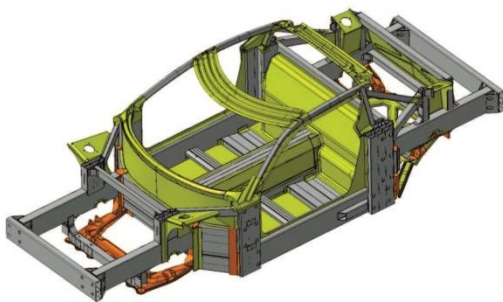
- ✓ Lightweight design
- ✓ Minimal vendor tooling invest

### Upperbody concept: multimaterial design

- ✓ Maximal design freedom
- ✓ Minimal vendor tooling invest
- OPTION: CFRP performance parts

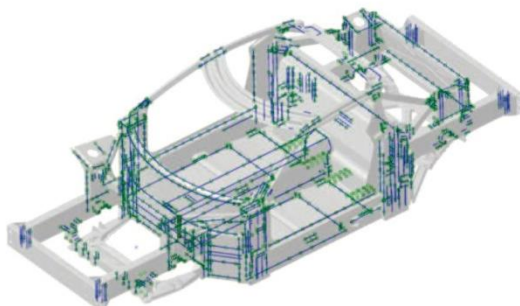
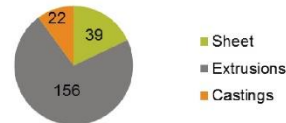
Affordable Hybrid Sports Car Concept for small series

## Mila Plus Material & Joining



### aluminium bodystructure:

Bodystructure material distribution by weight (217kg)



### cold joining technologies:

■ Bonding	96m
■ FDS	1350Stk.
■ Punch riveting	102Stk.

For higher volumes → hot joining technique

## Mila Plus Vehicle safety



Passive Safety load cases (Feasibility)

**Front-crash:**

- Deformable barrier ECE-R94 (ODB 56 kph)
- Rigid wall FMVSS 208 (56 kph, 0°)
- Rigid wall FMVSS 301 (48 kph, 30°)

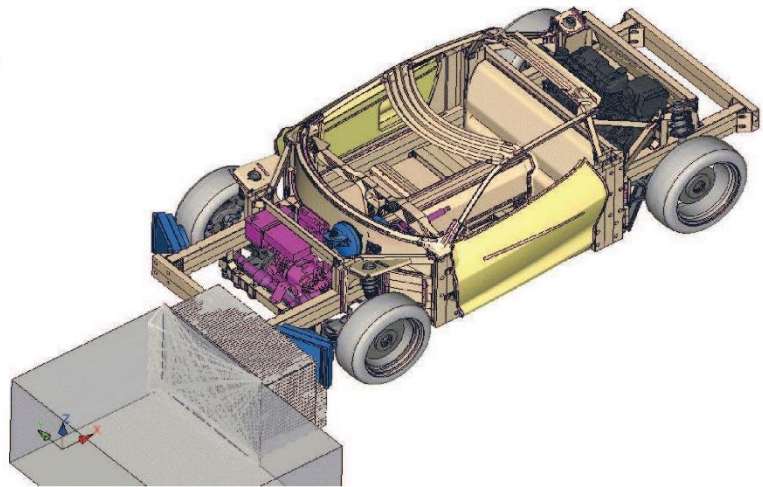
**Side-crash:**

- Deformable barrier FMVSS 214 (MDB 54 kph, 27°)
- Pole FMVSS 214 (32 kph, 75°)

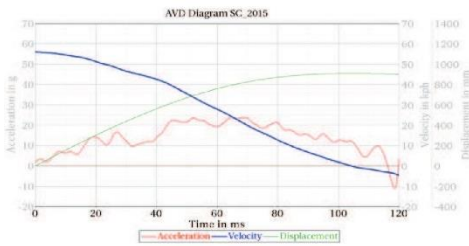
**Rear-crash:**

- Deformable barrier FMVSS 301 (MDB 80 kph)

Animation structure performance (front, side and rear crash)

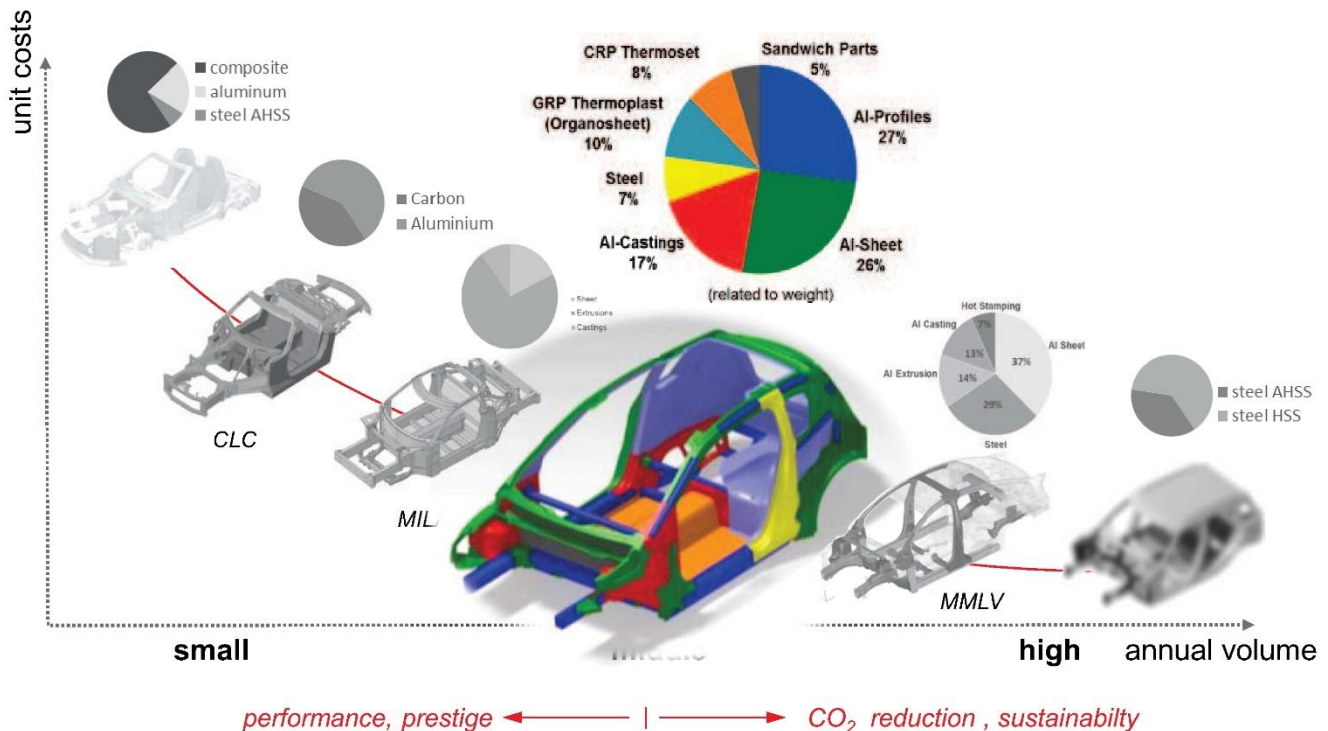


Acceleration Curve (Front crash)



Body structure ready for 5 stars rating according NCAP regulation

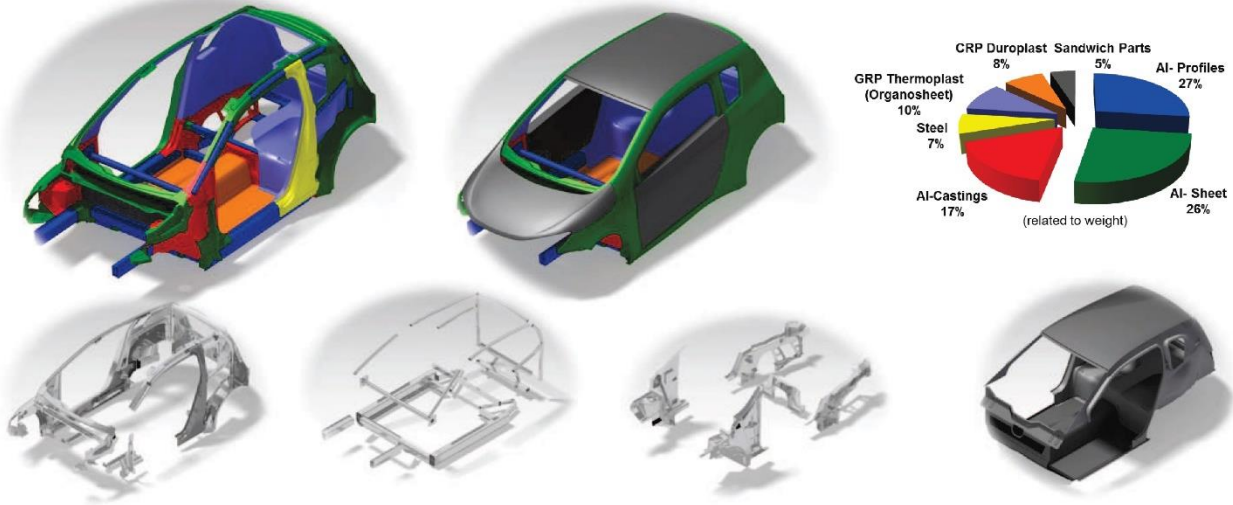
## CULT (Cars UltraLight Technologies)



Award winning multimerial design for small volumes



## CULT Material & Joining



Sheet: 58 Parts

Profiles: 32 Parts

Castings: 5 Parts

GRP Thermoplast: 10 Pcs.  
CRP Duroplast: 1 Pc.  
GRP- Sandwich: 1 Pc.  
Steel – Sandwich: 3 Pcs.

### Main targets:

BIW: < 140kg  
Series: 30.000 Jpy  
CO<sub>2</sub> emission: < 50gr/km  
Weight reduction overall: 300kg

### Joining technique:

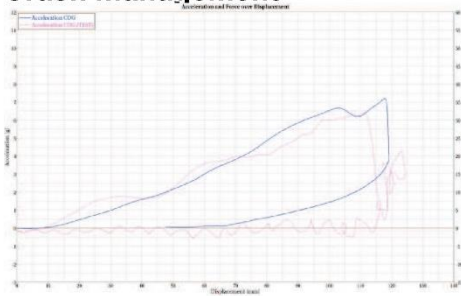
CMT→14m,  
Punch Rivets→778 Pcs.,  
FDS→465 Pcs.,  
Bonding→85m

Multimaterial approach to meet the targets

## CULT Simulation of Composite Material



### Crash management



Force and energy absorption

### Composite hood



Pedestrian Protection:



### Simulations done in CULT:

- Static stiffness and torsion; complete front crash simulation
- Crash:
- Composite hood: - pedestrian protection
- Front CMS: 3 different load cases, different temperatures, different speed

### Status/next steps:

redesign of the part for further weight reduction

Validated simulation for an efficient development process

## CULT Corrosion



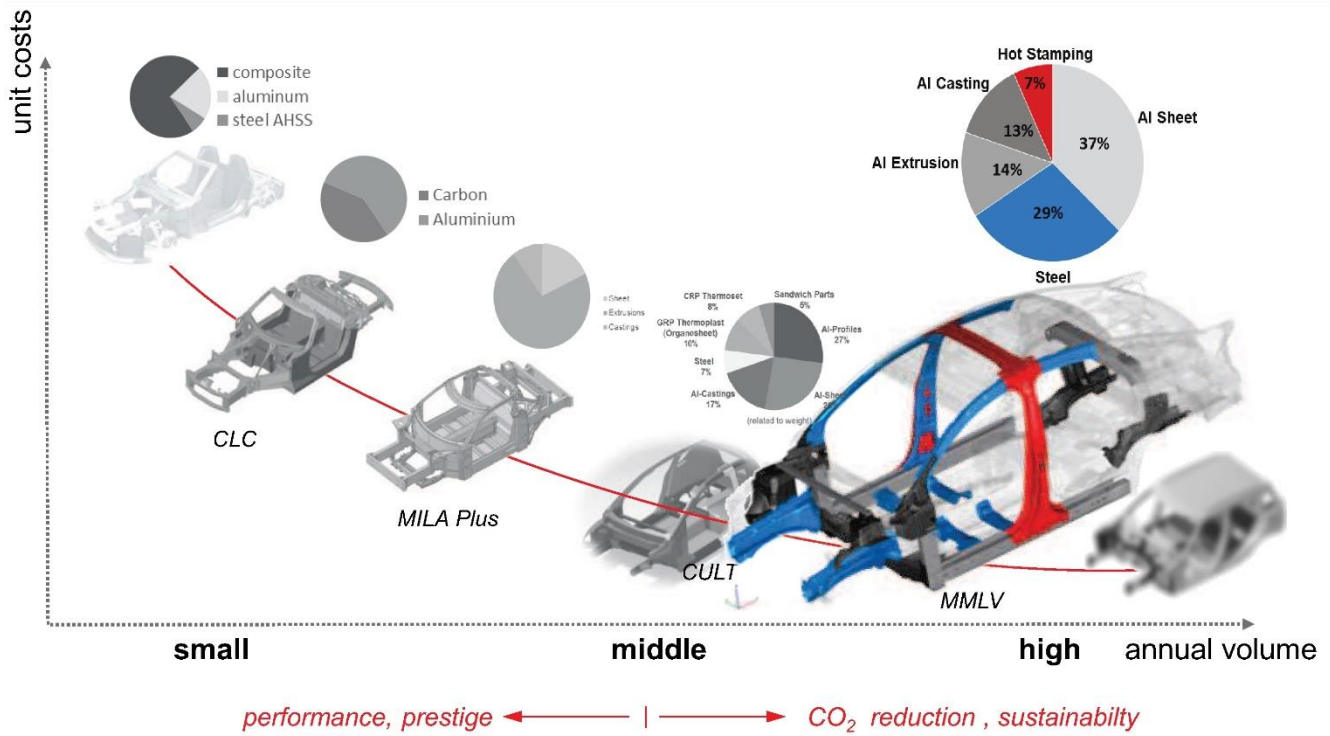
Electrochemical corrosion has to be respected

## Joining technology overview



Joining technologies for efficient lightweight design

## MMLV (Multi-Material Lightweight Vehicle)



MMLV a weight optimized high volume solution

## Multi-Material Lightweight Vehicle a weight optimized high volume solution

Christian Juricek  
Magna Cosma International

Asia Automotive Lightweight Symposium  
6<sup>th</sup> – 8<sup>th</sup> of July, Shanghai - China



## Agenda



- Project Motivation
- Partners & Collaboration
- Development Review
- Prototype Builds
- Vehicle Testing
- Summary



## Project Motivation



# Magna Steyr Engineering AG & Co KG

## Project Motivation



**CLEANER**  
Reduce energy consumption over vehicle lifetime

**LIGHTER**  
Reduce CO<sub>2</sub> emissions over lifetime

**AFFORDABLE**  
Efficient processes for the right material in the right place

Asia Automotive Lightweight Procurement Symposium 2015



- Make light weight design affordable for high volume applications
- Reduced vehicle mass for lower fuel consumption
- Utilize commercially available materials and manufacturing processes

Ch. Jurioek, Magna

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## Ford Motor Company



**DELIVER PRODUCT EXCELLENCE**

Asia Automotive Lightweight Procurement Symposium 2015

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### Statistics Q4 / 2014

**187,000**  
Employees

**62**  
Manufacturing Facilities

**6,3M**  
Global Vehicle Sales

**35**  
Global Products

**\$ 135,8B**  
(2014 Sales)

6

# Magna Steyr Engineering AG & Co KG

## Cosma's Global Presence



### Statistics Q4 / 2014

**34,000**  
Employees

**16**  
Countries

**61**  
Manufacturing Facilities

**23**  
Engineering  
Product Development  
Sales

**8**  
Tooling Facilities



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## Product Expertise

### Body & Chassis



#### BODY SYSTEMS



**BODYSIDE  
ASSEMBLIES**



**UNDERBODY  
ASSEMBLIES**



**CLOSURE  
ASSEMBLIES**



**I/P BEAM  
ASSEMBLIES**



**BUMPERS &  
DOORBEAMS**



**COMPLETE  
BODY-IN-WHITE**

Cosma produces a complete range of lightweight steel & aluminum body-in-white solutions from small stampings up to fully assembled body-in-white modules.

#### CHASSIS SYSTEMS



**FRAMES**



**CRADLES &  
SUBFRAMES**



**TWIST AXLES**



**CHASSIS MODULES**



**CONTROL ARMS**

Cosma is a market leader in complete chassis structure assemblies and modules. A variety of innovative lightweight steel & aluminum metalforming processes including hydroforming, rollforming, stamping, casting and bending can be applied to meet specifications.

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# Magna Steyr Engineering AG & Co KG

## Responsibilities



### Vehicle Structures Development:

- Body-in-White & Closures
- Chassis & Bumpers

### Process Development:

- Cost efficient Manufacturing
- Material, Assembly & Paint Concept



### Vehicle Integration Development:

- Powertrain & Suspension
- Interior & Glazing
- Paint
- Physical Testing



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## Deliverables



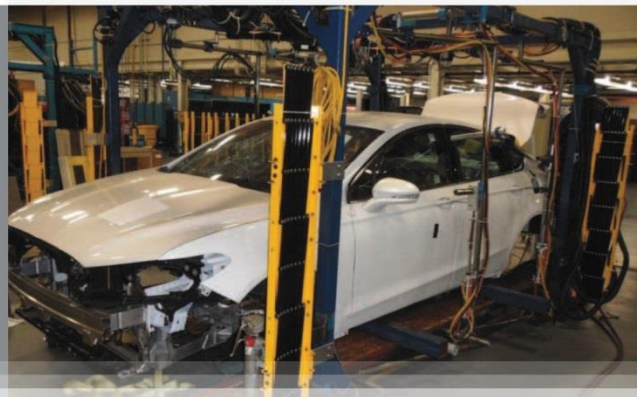
### Vehicle Structures Development:

- CAD Design
- CAE Analysis & Validation
- Prototypes (complete vehicle and paint)
- Feasibility High Volume Production
- Manufacturing Footprint



### Vehicle Integration Development:

- Integration of Vehicle Components
- Physical Testing:
  - Safety & Fatigue
  - NVH & Corrosion



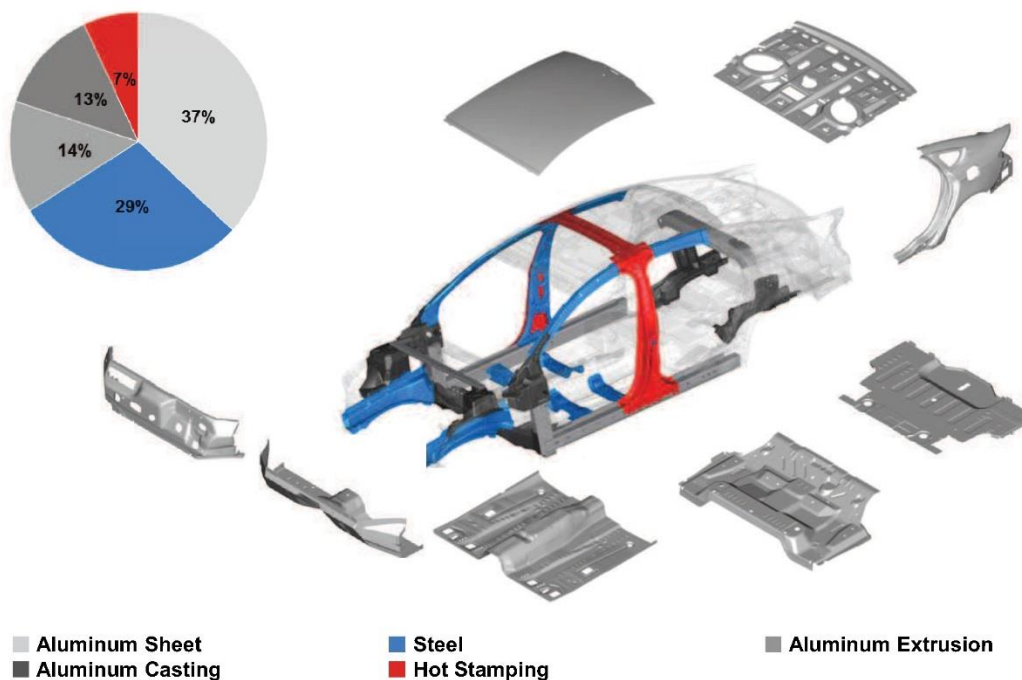
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## Body-in-White



76,7 kg Mass Reduction from Baseline (23,5%)



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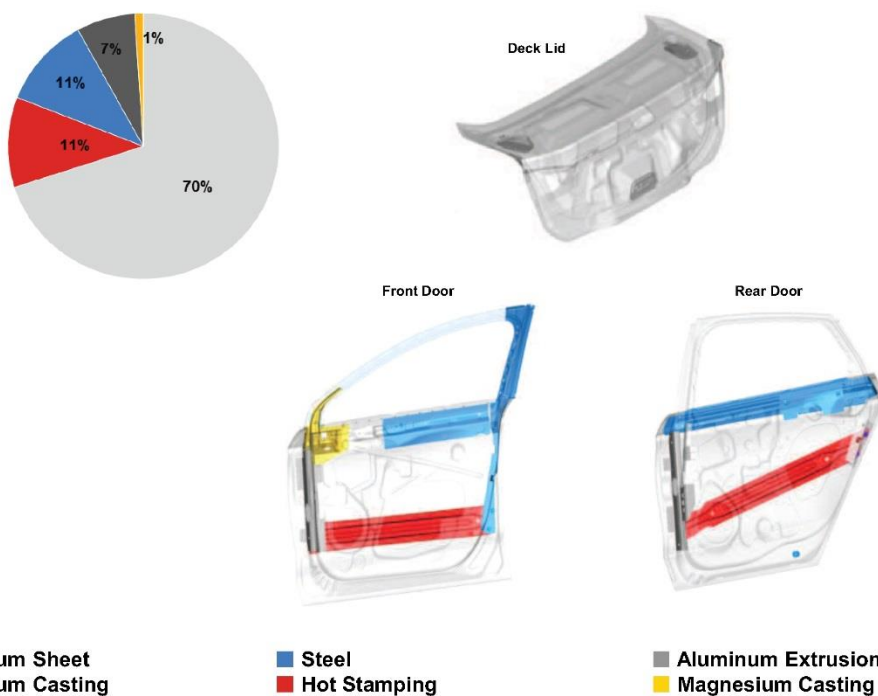
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## Closures



29 kg Mass Reduction from Baseline (29,7%)



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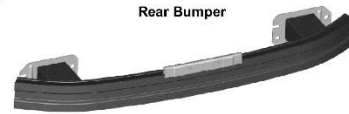
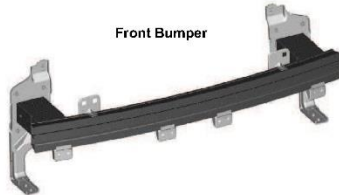
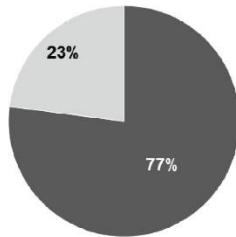
12



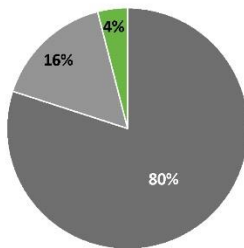
## Bumper Structures and Subframes



### Bumpers - 11,4 kg Mass Reduction from Baseline (30,9%)



■ Aluminum Casting ■ Aluminum Extrusion ■ Aluminum Sheet ■ Other (bushings ... etc.)



### Subframes - 27 kg Mass Reduction from Baseline (47,4%)

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## Powertrain and Suspension

Ford Developments



### Powertrain – 73 kg mass reduction



1.0 liter 3cyl engine



6-speed Automatic Transmission

### Suspension – 74 kg mass reduction (37%)



Tall, Narrow Tires  
155/70R19



Thermal Coated  
Brake Rotors



Carbon Fiber  
Wheels 19"x5"



Coil Springs  
Hollow Steel & FRP



Stabilizer Bars  
Hollow Steel

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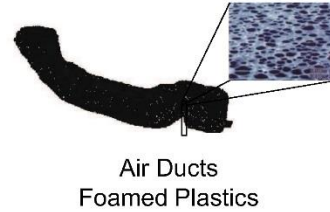
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## Interior and Glazings

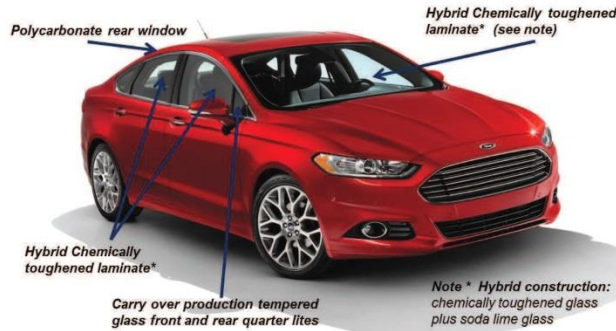
Ford Developments



### Interior & Climate Control - 50 kg mass reduction (25%)



### Glazing - 12 kg mass reduction



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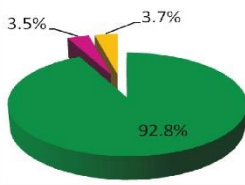
## Weight Review



### 165 kg Mass Reduction (31,9%) Vehicle Structures

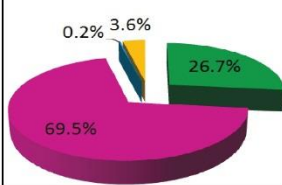


Baseline	
BIW	316.04 kg
Closures	92.17 kg
Chassis	89.07 kg
Bumpers	20.38 kg
<b>Totals</b>	<b>517.66 kg</b>



MMLV Concept	
BIW	231.33 kg
Closures	57.23 kg
Chassis	52.90 kg
Bumpers	11.13 kg
<b>Totals</b>	<b>352.58 kg</b>

31.9% Reduction



Steel Aluminum Magnesium Other

### 364 kg Mass Reduction (23,3%) Complete Vehicle



MMLV	Multi Material Lightweight Vehicles	
Description	2013 Fusion	MMLV Final Design
Body Exterior & Closures [kg]	694	456
Body Interior & Climate Control [kg]	206	161
Chassis [kg]	350	252
Powertrain [kg]	340	267
Electrical [kg]	69	59
<b>Total Vehicle [kg]</b>	<b>1559</b>	<b>1195</b>



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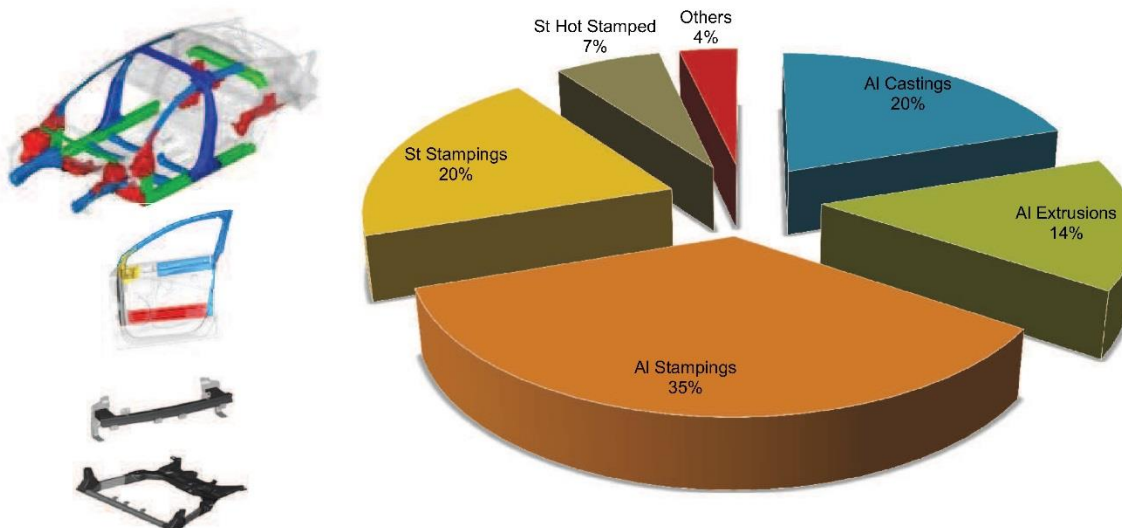


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## MMLV Material Contribution



### Material Contribution Vehicle Structures



**165 kg Mass Reduction from Baseline (31,9%)**

## Joining Technologies



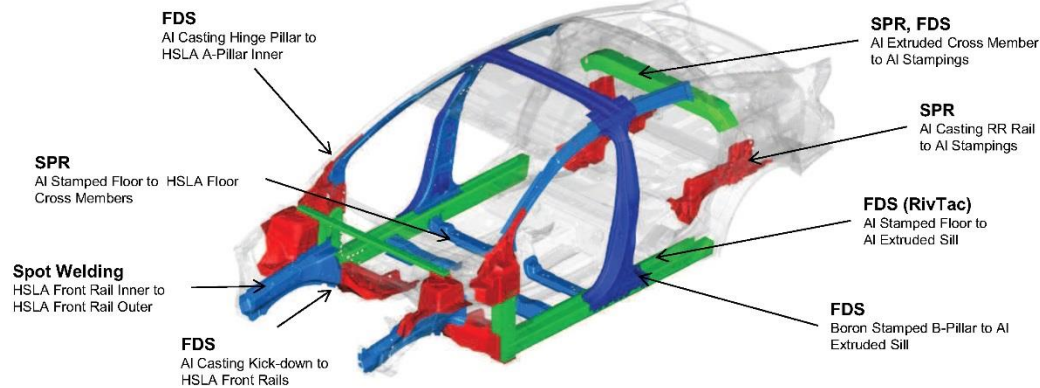
Self-pierce Rivet (SPR)



Flow Drill Screw (FDS)

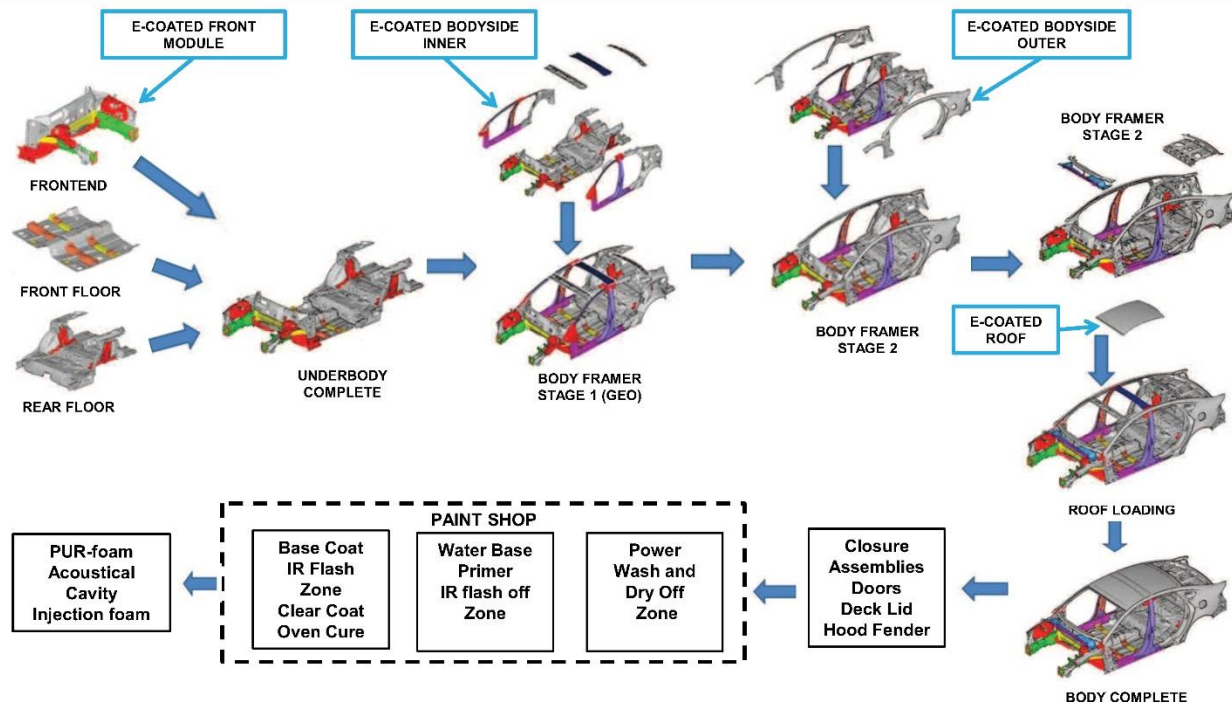


RivTak™ Technology



**All BIW joints include a heat (Dow Betamate 73305) adhesive or air cured (Dow Betamate 73326/73327) adhesive for improved durability and to create a barrier to prevent galvanic corrosion.**

## Assembly Process & Corrosion Strategy



The assembly/corrosion strategy allows for a multi-material BIW to be run thru current OEM paint body shops creating the possibility to implement into existing OEM facilities.

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## Prototypes & Testing

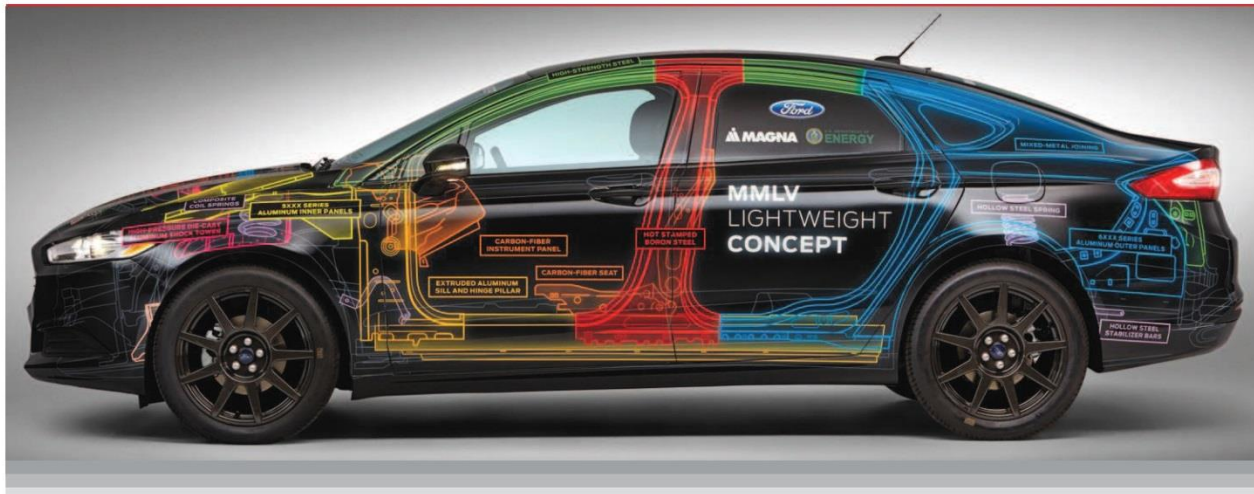


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## Environmental Benefit



Environmental benefits of the Multi-Material Lightweight Vehicle Concept vs. the 2013 Ford Fusion built and driven for 250.000 km in North America:

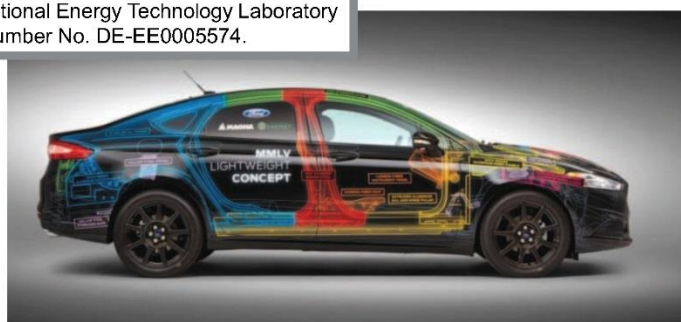
- 16% reduction in CO<sub>2</sub> emissions
- 16% reduction in total primary energy (LCA)
  - fuel savings, less burden of production and end of life phases

## Acknowledgement



**Thanks to the DOE,  
Ford and our Magna colleagues**

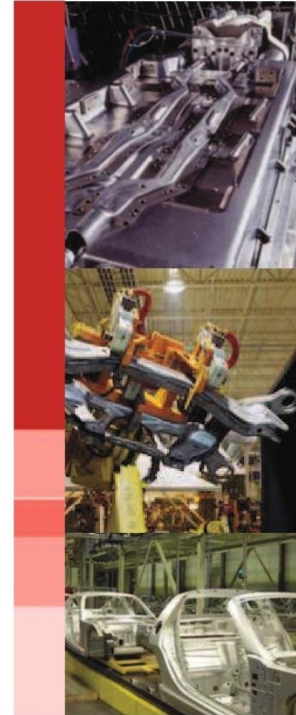
This material is based upon work supported by the Department of Energy National Energy Technology Laboratory under Award Number No. DE-EE0005574.



## Summary



- Department of Energy has got validated results showing affordable lightweight solutions.
- Based on available material and technologies a concept for high volume applications has been developed.
- Reductions of CO<sub>2</sub> emissions and energy consumption have been validated over vehicle lifetime.
- Early stage development collaboration of legislation, OEM and supplier leads to sustainable solutions.



**The future is ours to make.**



**Mr. Andreas Mueller**  
**CEO**

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**CHE 9015 St. Gallen-Winkeln**  
**Tel.: +41 71313 8888**  
**[www.dgs-druckguss.com](http://www.dgs-druckguss.com)**

## **TITLE**

### **Localization And Industrialization Of Cast Aluminium Structural Applications**

## **ABSTRACT**

Automotive manufacturers and their suppliers must innovate in all areas of vehicle design, in order to maximize fuel efficiency to meet federal CO2 guidelines. To realize this goal, automakers started in the late 90ies to integrate aluminium cast parts not only in the hang on parts, but also in the body-inwhite car structure (BIW).

German OEMs, as innovation leaders on this sector, started with those BIW structures in the premium car segments, like the Audi A8. Meanwhile also cars in the field of middle sized class, like the new Daimler C-Class, have a wide range of different structural casted parts, which led to a weight reduction of around 100kg per car. Some European Companies, one of them is the DGS-Group, got specialised in this growing sector of structural castings over the last decade. To realise the necessary mechanical properties, new alloys, a new vacuum supported casting process and new heat treatment technology needed to be developed and industrialised. Due to largely increasing volumes and necessary price reductions, the processes needed to be redesigned, i.e. with highly automated deburring- and machining-processes.

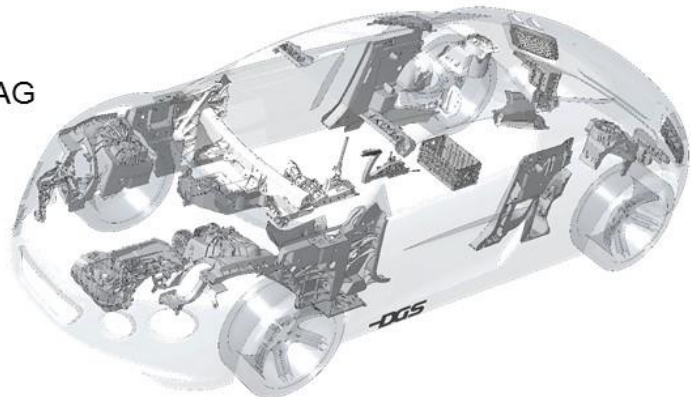
Many Casting companies had to bear millions of EUROS, Swiss Francs, Dollars etc. for development and ramp up costs for this new technology over the last years. Anyhow, as one of the technology leaders in this segment, DGS needed to create a strategy to be one of the first companies producing such parts in China and to meet the demands of their customers. These demands have been i.e. to assure worldwide all the same specifications and quality as in Switzerland/Europe and being able to realise very quick ramp-up times in 4 continents nearly at the same time.

The key to success was the decision of our customer, to involve key suppliers very early in the product development process and to support all the suppliers during the final product and process development. All involved casting suppliers worldwide have been linked together in project development meetings, which assured same construction and process philosophies over all casting suppliers. For us as DGS this led to a global partnership, which helped both sides to assure same quality, fast ramp up times and quick know-how transfer over 3 continents. Another key factor for us as supplier was, to assure the same level of technology in China as in Switzerland and to assure, having all necessary people trained in time. The speech and the presentation will give a better insight in these processes, in the strategy and in the way of realisation of this challenging project.



## Localization And Industrialization Of Cast Aluminum Structural Applications

Dipl.- Ing. Andreas Müller  
CEO of DGS Druckguss Systeme AG



“Asia Automotive Lightweight Procurement Symposium”  
6th – 8th of July 2015, At the Jumeirah Himalayas Hotel in Shanghai, China



## Content

1. Overview DGS Group
2. Trends in automotive industry
  - a) Globalization
  - b) Platform strategy
  - c) Lightweight development
3. Customer's view: project Daimler C-Class BR205 with worldwide production sites
4. Strategy of DGS to meet customer demands

*Customer's view*





## Overview DGS-Group

### 3 Locations

- Switzerland, St. Gallen since 1950
- Czech, Liberec since 1999
- China, Nansha since 2007, new plant since 2013

### Products

- High pressure die casting parts in aluminum and magnesium
- 90% automotive, 10% commodity
- Structural parts, transmission- steering- and aggregate components

### Expertise

- System provider with material,- product-and process development
- Casting, heat treatment, machining, coating and assembly
- 48 die casting machines from 250to. to 3200to.

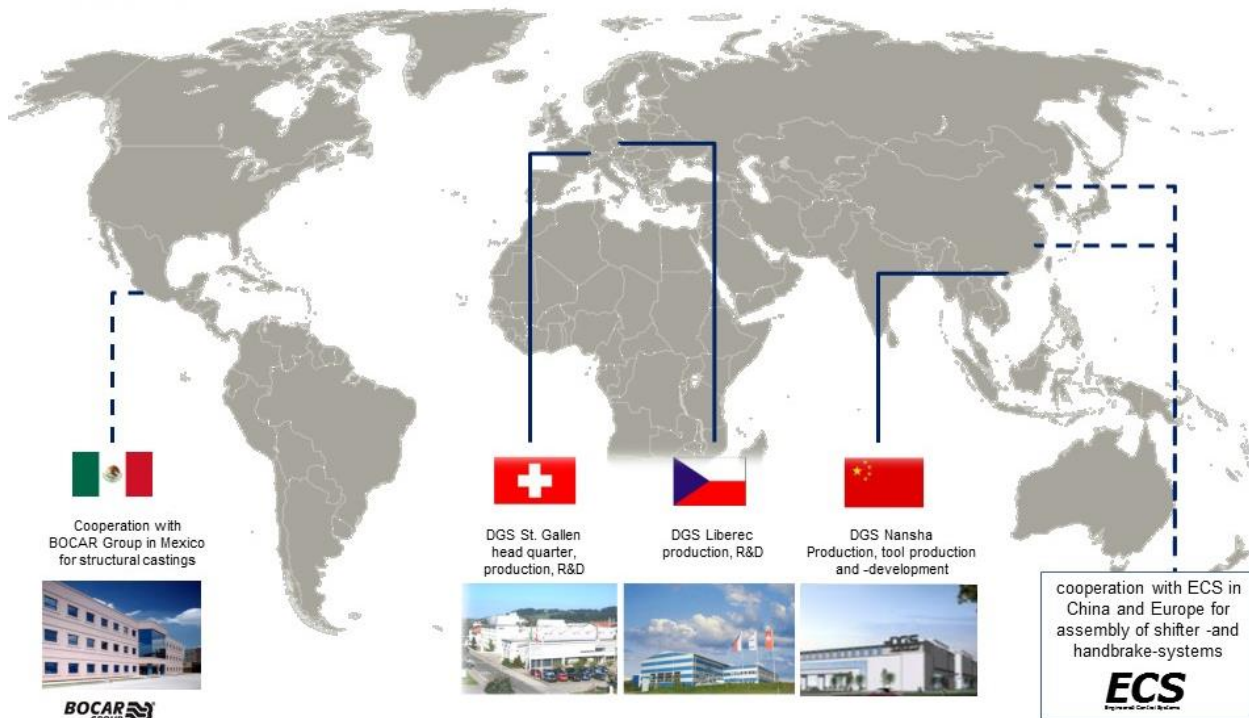
### Employees

- 900 employees (Switzerland 370, Czech Republic 320, China 210)
- Head Quarter and R&D in Switzerland
- Globally acting project teams

**Innovations and globalization are driver for our growth !**



## DGS Locations incl. Cooperation



# DGS Druckguss Systeme AG



## History



## DGS customers and products





## Trends in the automotive industry

### Globalisation

- German OEM's localize production in NAFTA and Asia
- Parallel ramp ups of new cars in all countries
- Suppliers have to follow their OEM-customers and have to globalize their production network



### platform strategies

- Number of platforms decrease by -30% down to 150 till 2020
- „Top Ten“ platforms double their volumes to 33 Mio. cars per year
- VW and Daimler Benz will have >95% of their car production on 3 platforms each !



### light-weight-construction

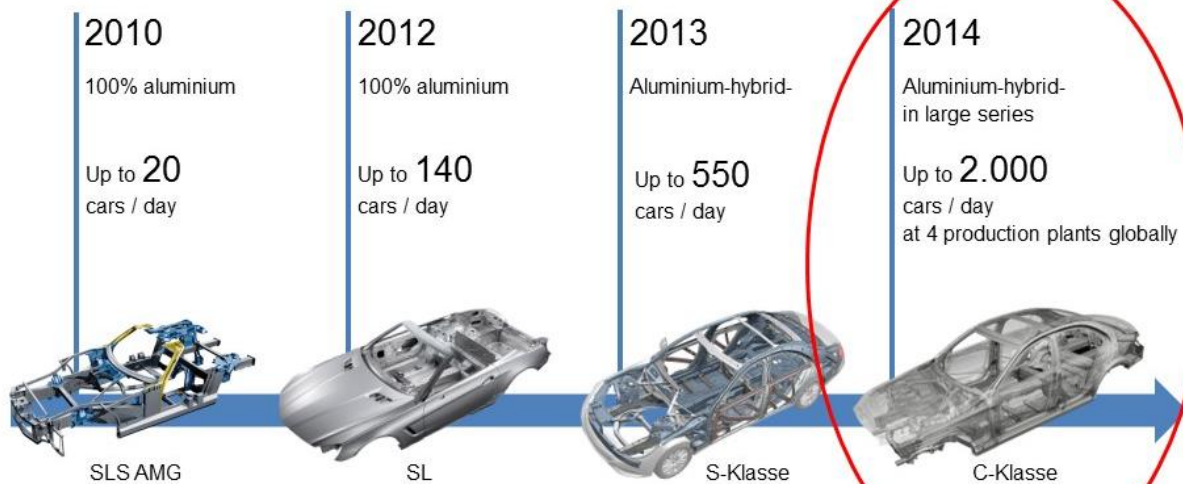
- new models get lighter (i.e. new VW Golf -100kg, new c-class -100kg, new Audi Q7 -300kg)
- usage of aluminum per car was 50kg in 1990, 140kg in 2010 and in 2020 we expect 160-180kg aluminum per car in average



## Daimler's C-class project



*Customer's view*



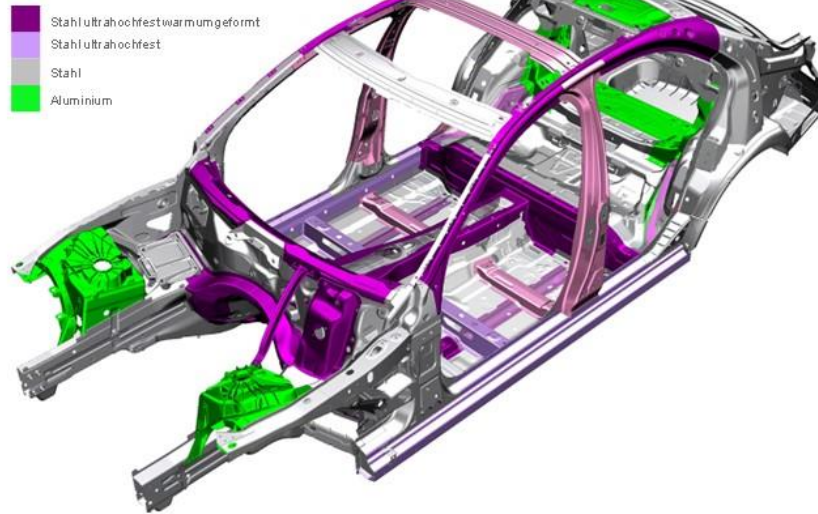
Source: Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Daimler's C-class project

### Umsetzung des Leichtbaukonzepts für die neue C-Klasse

*Customer's view*


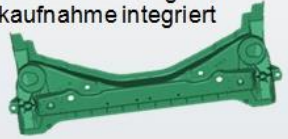




Source: Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Structural parts in Mercedes' BR205 C-class

*Customer's view*

 <p><b>Konsole Federbeindom LI+RE</b> Gewicht ca. 3,1 kg Größe 450 x 420 x 330 mm<sup>3</sup> zentraler Anguss über 3-Platten-Werkzeug, Federbeinanlagefläche und Fahrwerkaufnahme integriert</p>	<p><b>Querträger über Hinterachse</b> Gewicht ca. 5,2 kg Größe 425 x 1140 x 125 mm<sup>3</sup> Hinterachsverschraubung und Fahrwerkaufnahme integriert</p> 
 <p><b>Aufnahme Stossdämpfer LI+RE</b> Gewicht ca. 2,5 kg Größe 530 x 295 x 410 mm<sup>3</sup> Anlagefläche für Stossdämpfer integriert, modellspezifische Bearbeitung</p>	<p><b>Längsträger LI+RE</b> Gewicht ca. 1,4 kg Größe 480 x 315 x 290 mm<sup>3</sup> Hinterachsverschraubung integriert</p> 

AISI10MnMg nach DBL4918.30 mit zweistufiger Wärmebehandlung, Allgemeintoleranz nach MBN36022

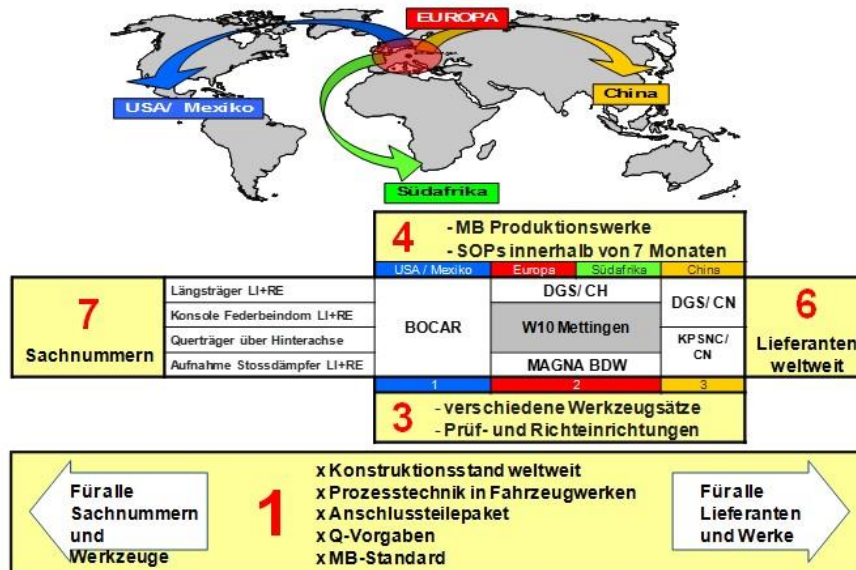
Source: Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Global setup

### Internationaler Produktionsverbund - Übersicht

*Customer's view*



Source: Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Challenges of global setup

*Customer's view*

- Structural parts in large series
- worldwide availability of structural parts
- supplier qualification – new suppliers and new locations without experience in structural castings
- 4 SOPs within 7 months
- 3 suppliers for each part in each car-production site of Daimler
- 3 car-production plants out of 4 without experience in structural castings
- Transport times for parts and tools
- Mutual understanding about norms, specifications and requirements
- Time-lag, language, cultural differences, different public holidays

Source: translated from Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Success factors for Daimler's global setup

*Customer's view*

- prototype-tool concept was taken over as series-concept for NAFTA production
  - mutual fixation of technical realization for each part together with lead supplier; realization by all further suppliers with same concept
  - trials for packaging and transport; worldwide common concept for packaging
  - up to now exchange of experiences concerning technology between casting companies in cooperation with Daimlers R&D; this assured fast development of high level of maturity in the processes
- ⇒ deep and trustful mutual teamwork in global project team between suppliers and Daimler

Source: translated from Presentation at Aalen Symposium in May 2015 by Dr. M. Pfitzer



## Key factors of DGS's strategy

1. Innovation in key product segments with mutual R&D projects together with our key customers
2. Early stage globalization
3. Cost optimization by automatisation, intelligent tool concepts, developing LCC-cost base
4. Clear focus on key products
5. All necessary processes incl. process development in-house; tool-development and -production in house
6. Intense training programs in Switzerland and China
7. Partnerships to ensure fast know-how transfer, having competence in all process steps and global setup



## DGS's in-House strategy



- all processes in-house
- lean factory setup
- high productivity
- short lead times and reaction times
- best practice engineering
- no interface problems
- low buffers



## DGS's approach to meet targets

1. 4-cavity tools on 3200t DCM in Europe for highest productivity
2. central project management incl. design of processes by respecting local requirements and frame conditions
3. new Greenfield site in China for optimised layout
4. central sampling of tools in Europe, also for partner Grupo Bocar in Mexico
5. open book philosophy with Daimler's foundry and with partner in project „Grupo Bocar“
6. Deepen and intensifying partnership with **GRUPO BOCAR** 
7. Own tool-shop in China to assure optimised know-how transfer to China



## DGS's technical competence for structural parts

1. Sophisticated Tool development with using state of the art simulation tools and realizing
  - a) extremely high vacuum
  - b) Multi-cavity tools
  - c) Special cooling areas capable for minimum spraying, i.e. by using 3D-printed inserts
2. Mutual alloy- and heat-treatment-process development together with customers lead to additional weight saving potential of 10% in compare to state of the art materials and processes



## Pictures from production in Switzerland



Die casting cell 3200t for 4-cavity production





## Pictures from production in Switzerland



Heat-treatment line



## Pictures from production in Switzerland



- 1) Heat-treatment
- 2) Robot grinding
- 3) Measuring, correcting
- 4) machining
- 5) Helicoil assembly

Heat treatment, grinding, measuring, machining and assembly process chain



## Pictures from production in Switzerland



Robot grinding



Measuring, correcting



machining, helicoil assembly



## DGS China at a glance

### Location

- Nansha/Guangzhou (Province Guangdong)
- approx. 10'000m<sup>2</sup> production space at new Greenfield plant in stage 1

### Alloys

- **Aluminum** 226- $AlSi9Cu3$  (Fe),  $AlSi10MgMnSr$
- **Magnesium** AZ91, AMZ40

### Expertise

- high pressure die-casting incl. heat-treatment, machining and assembly
- 10 DCM (350t up to 1650t), partially in hybrid for Al and Mg
- Tool shop for tools up to 1600t die casting machines





### Employees

- 210 employees



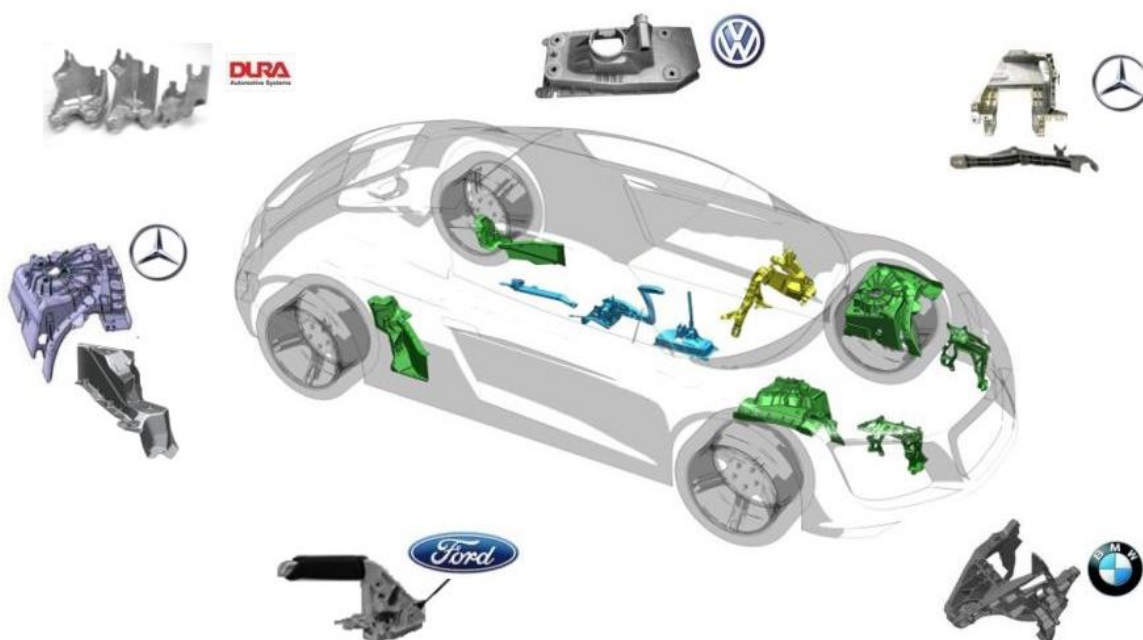


## Development of China plant

- 
• Start planning & construction
- 
• First machine installed
- 
• First shot structural part opening ceremony
- 
• Official SOP of Daimlers BR205 C-Class structural parts



## Products of DGS Nansha



# DGS Druckguss Systeme AG



## Pictures of DGS Nansha



DGS Druckguss Systeme AG  
Industriestrasse 10, 9015 St. Gallen

Page 25



## Pictures from DGS Nansha



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## DGS Nansha: grinding, correction and machining



## DGS Nansha: tool shop



# DGS Druckguss Systeme AG



Feel free to contact us

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Thank you !



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## **TITLE**

The development and application of Aluminum Alloy High Vacuum Die Casting Technology

## **ABSTRACT**

It is aimed to the applications of high vacuum die-casting in the important aluminum-alloy parts of auto. The novel multi-way high speed vacuum die casting technology was researched and developed. The key technology is to vent gas of the die cavity from multiple ways, which means to exhaust the air out of the injection sleeve, die cavity, and the die body. Another key is vacuum valve, an active vacuum valve driven by hydraulic pressure was designed and manufactured, whose function is to open and close the exhausting gates. The others such as plunger tip and its seal, lubrication, gas content test method etc are also studied. At last front sub-frame, an auto structural part developed by Guangdong Hongtu Technology(holdings) Co. Ltd was introduced.

# Guangdong Hongtu Technology Co.,Ltd



广东鸿图科技股份有限公司

证券简称：广东鸿图 证券代码：002101

**精密铸件 源自广东鸿图**

广东鸿图(GHT)  
欢迎您  
Welcome you  
Guangdong  
HongTu



## Development and Application of Al Alloy High Vacuum Die Casting Technology

Li Wan  
2015.6.30



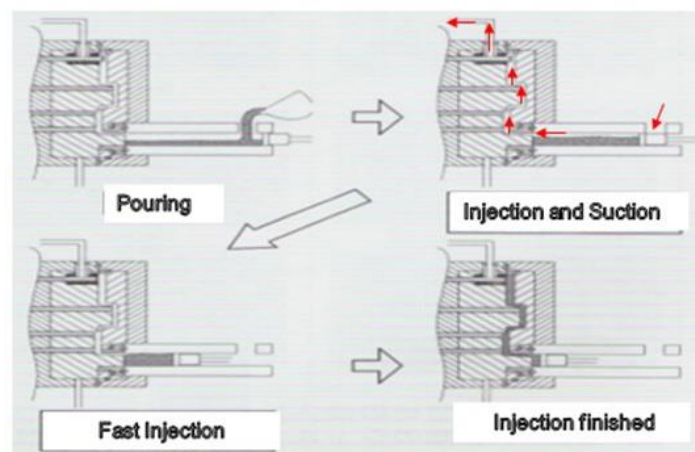


## Contents

- 1 What is High Vacuum Die Casting Technology
- 2 Principle of High Vacuum Die Casting Technology
- 3 Development of Die Casting Front Sub-frame
- 4 Summary



## 1 What is High Vacuum Die Casting Technology

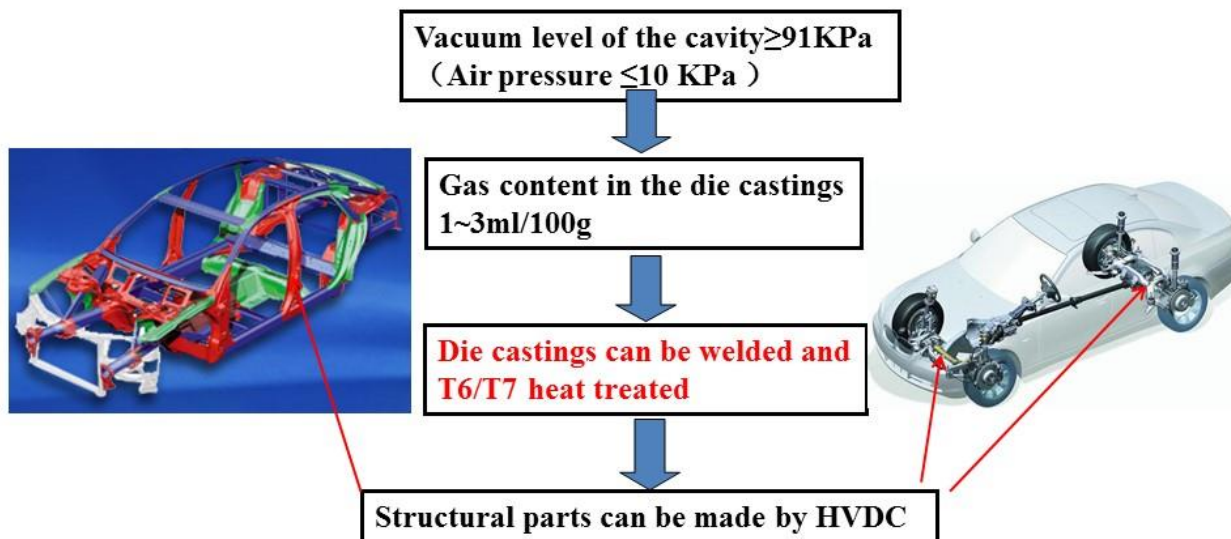


**Schematic of Vacuum Die Casting**

Alloy liquid is injected into the die cavity after the air in the cavity was suctioned by vacuum pump. Gas porosity defect caused by air entrapped can be eliminated.



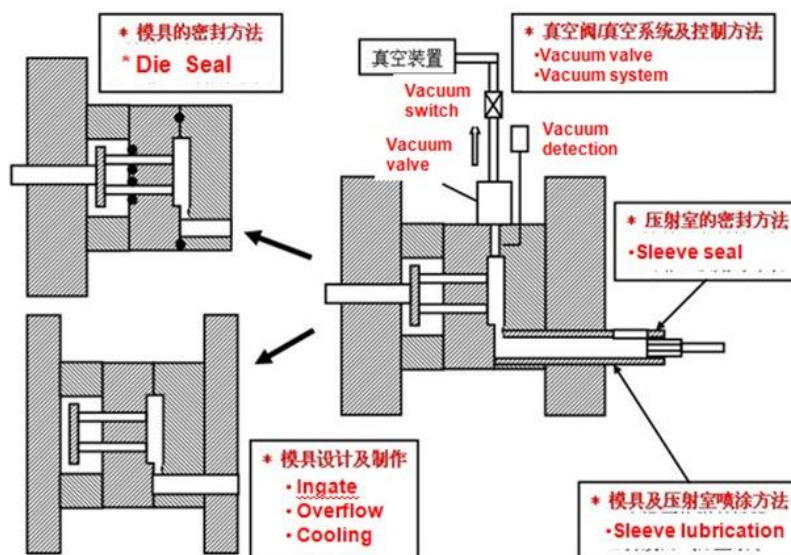
## 1 What is High Vacuum Die Casting Technology



Character of High Vacuum Die Casting



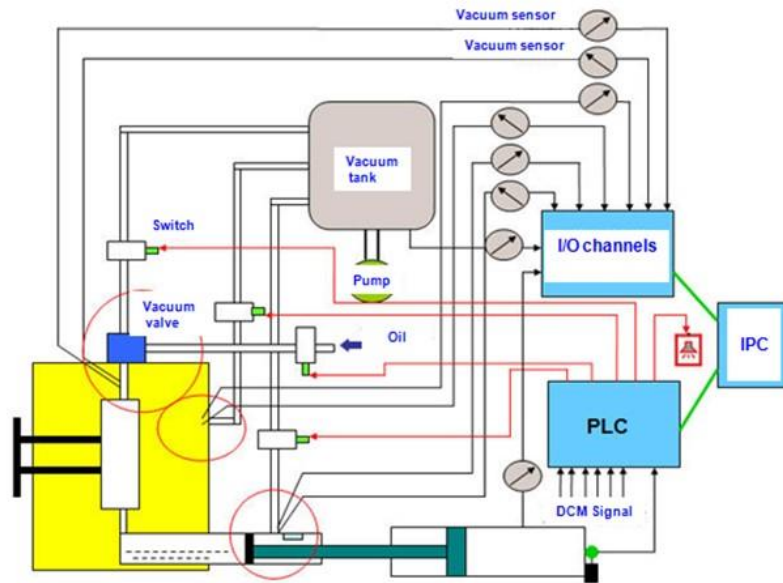
## 1 What is High Vacuum Die Casting Technology



Key of High Vacuum Die Casting



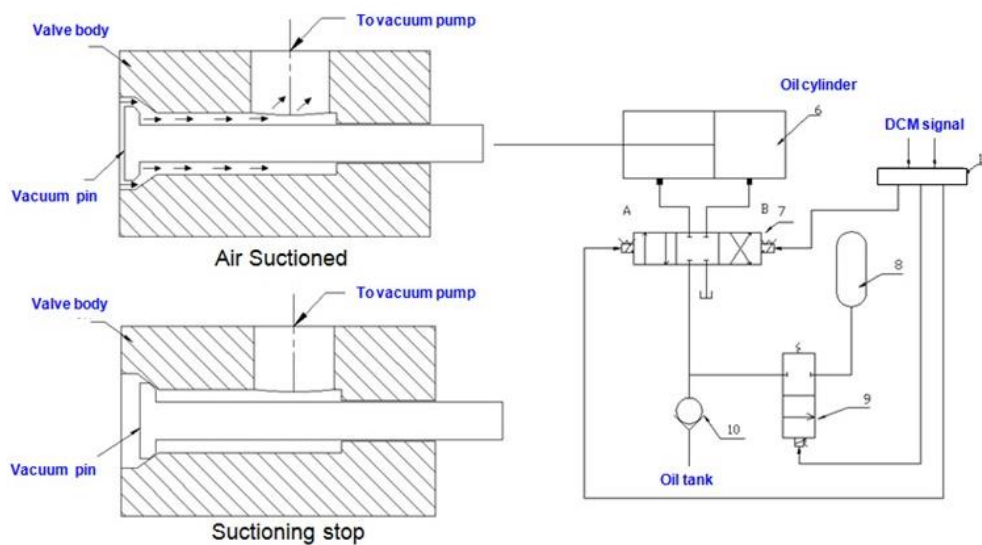
## 2 Principle of High Vacuum Die Casting Technology



Schematic of High Vacuum Die Casting by Multi-channels suction



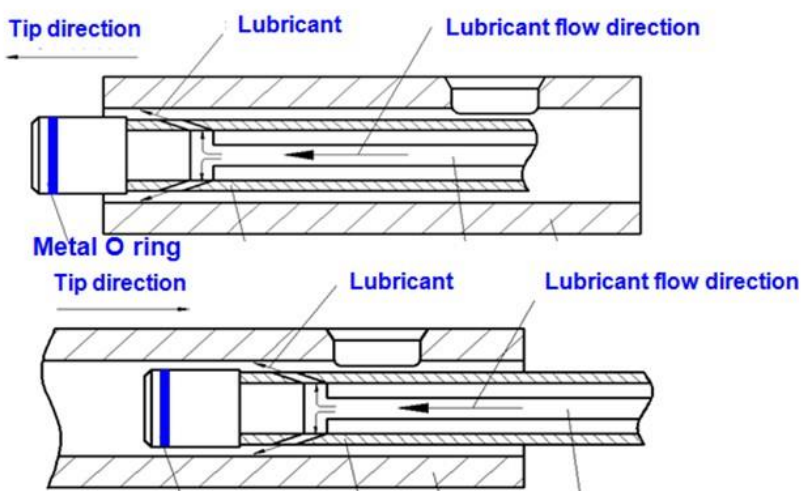
## 2 Principle of High Vacuum Die Casting Technology



Schematic of Vacuum Valve Driven by Oil



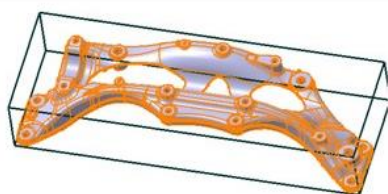
## 2 Principle of High Vacuum Die Casting Technology



Schematic of Tip Seal and Sleeve Lubrication



## 3 Development of Die Casting Front Sub-frame



Part size: 677.79mm X 115.40mm X 232.42mm



name	
Calculation mode: Exact	
Type: Volume	
Equivalent ID	
Characteristics	
Volume	875804.234mm <sup>3</sup>
Area	591842.101mm <sup>2</sup>
Mass	2634.671g
Density	2700kg/m <sup>3</sup>
Inertia / G	
Inertia Matrix / G	
Ixx0	8.963e+006mm <sup>2</sup>
Iyy0	8.963e+006mm <sup>2</sup>
Principal Moments / G	
M1	8.963e+006mm <sup>2</sup>

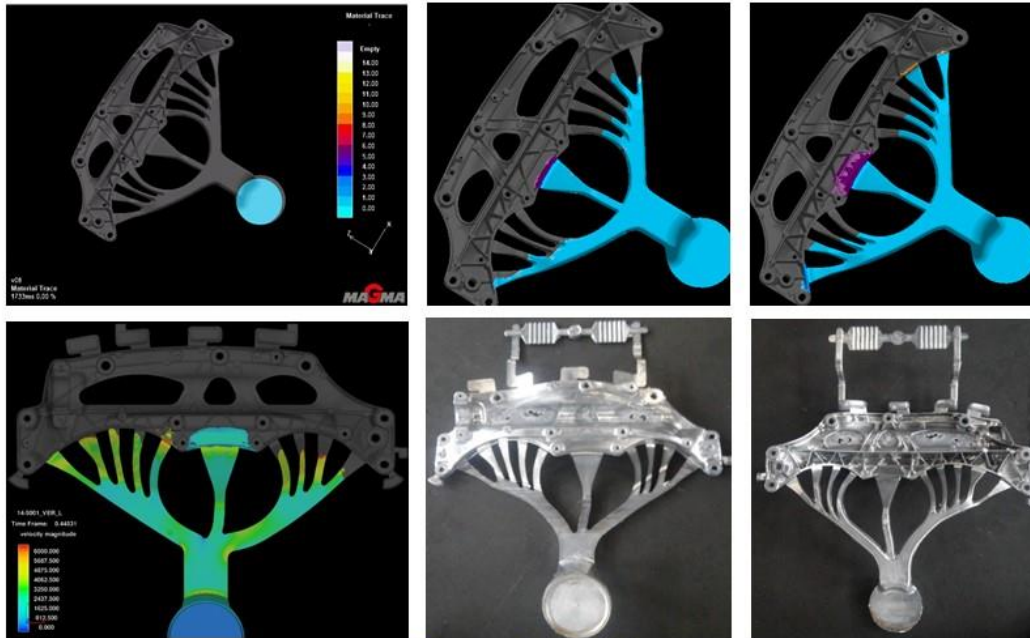


Part weight: 2634.67g Alloy: AISi8MnMg Heat treatment: T5  
 Tensile strength:  $\geq 220\text{MPa}$ , Yield strength:  $\geq 150\text{MPa}$ , elongation:  $\geq 5\%$   
 Gas content: 10cc/100g(Ingate side), 15cc/100g(Overflow side)

### Front sub-frame



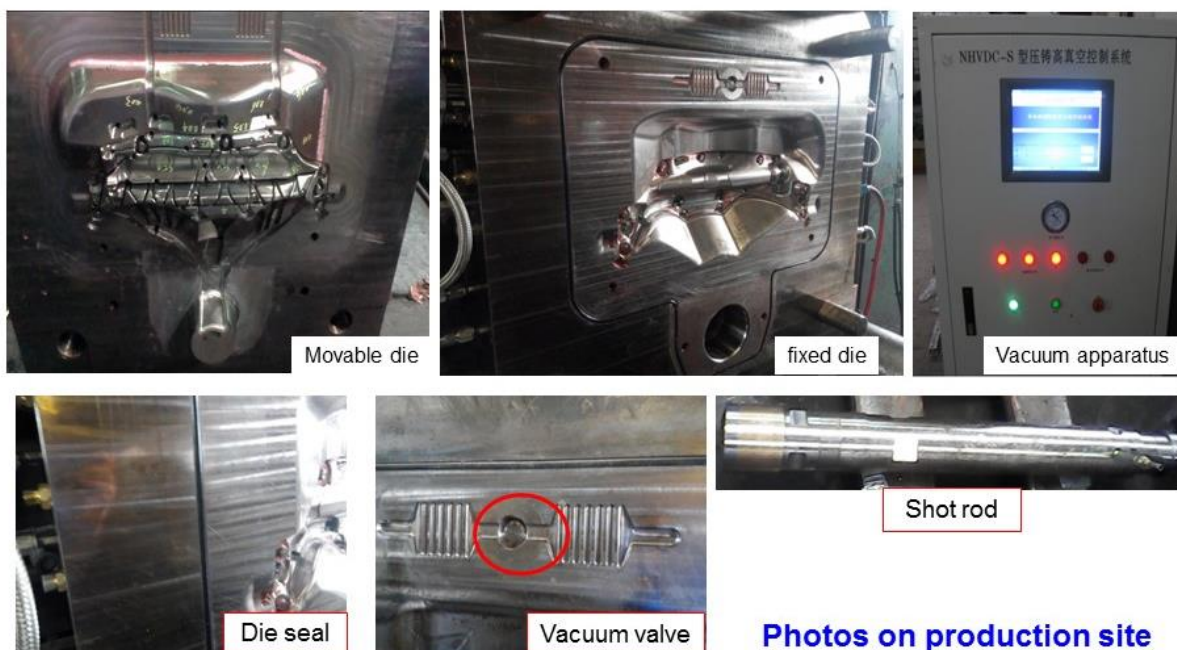
## 3 Development of Die Casting Front Sub-frame



Flow simulation



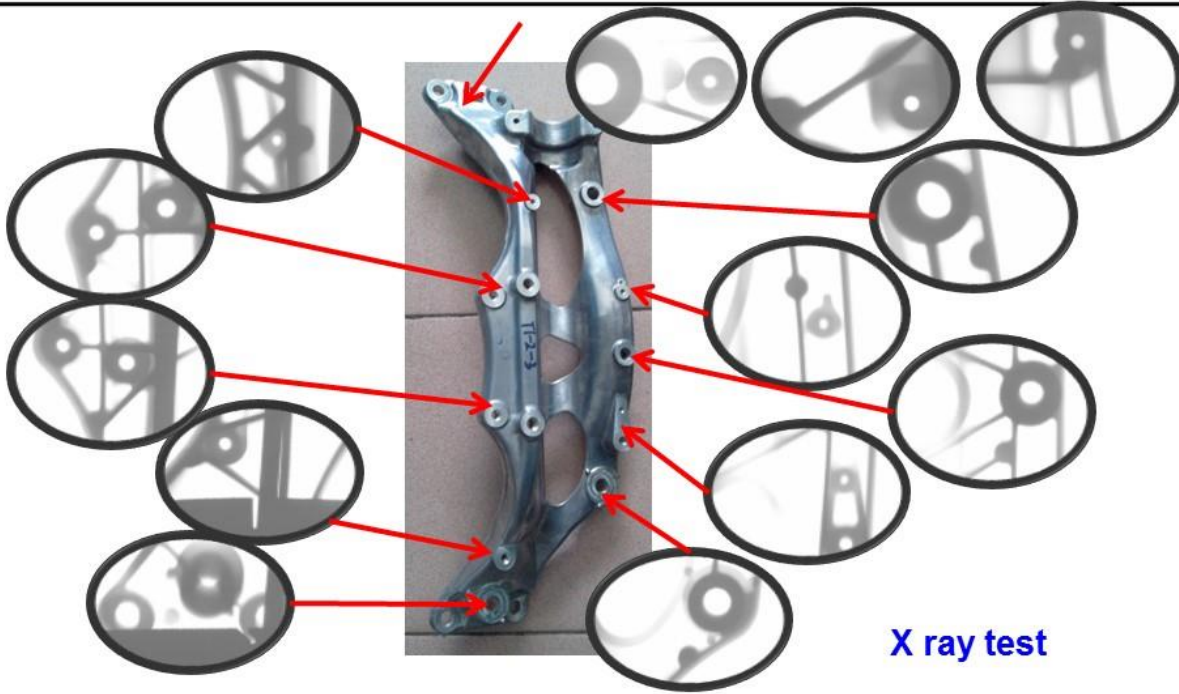
## 3 Development of Die Casting Front Sub-frame



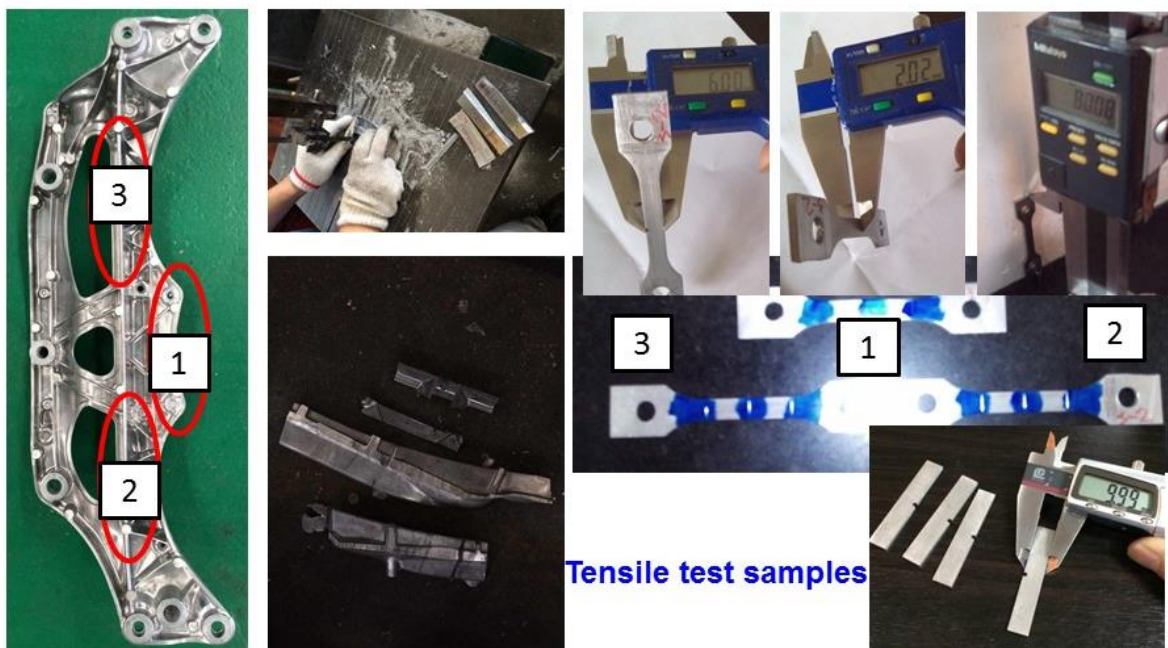
Photos on production site



### 3 Development of Die Casting Front Sub-frame



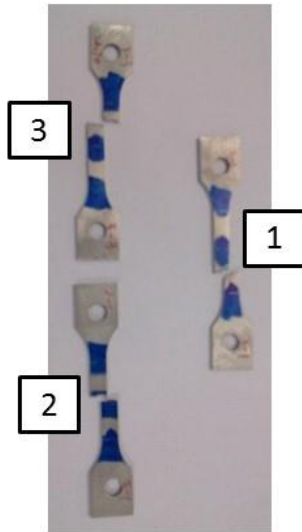
### 3 Development of Die Casting Front Sub-frame





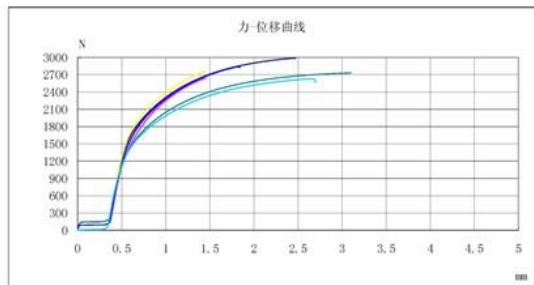
## 3 Development of Die Casting Front Sub-frame

金属材料拉伸-板材试验报告



执行标准	JIS Z2241-1998	供应商	华劲
原始点距离	25 mm	试样编号	
材料牌号	H03SF	材料批号	

	试样宽度 (b)	试样厚度 (a)	原始横截面积	最终标距	最大力 (Fm)	抗拉强度 (Rm)	屈服强度 (Rp0.2)	破断伸长率 (A)
	mm	mm	mm <sup>2</sup>	mm	kN	MPa	MPa	%
第1根	5.97	2.02	11.97	26.43	2.79	232.81	196.42	5.72%
第2根	5.98	2.00	11.96	26.26	2.64	220.46	158.78	5.04%
第3根	5.90	2.05	12.28	26.42	2.75	224.35	159.97	5.98%
第4根	5.96	2.01	11.98	27.14	2.75	229.15	161.43	8.59%
第5根	6.00	2.02	12.12	26.52	2.83	233.50	160.02	6.98%
第6根	5.97	1.99	11.88	26.37	2.63	221.38	158.66	5.48%



Tensile test results



## 3 Development of Die Casting Front Sub-frame



材 質	工 法	試験方法 1. 含気量 (含気量測定装置GV-700[試管-018]) 含気量: 根据压铸产品測量基準42003-D3
鑄 造 日	鑄造場所	1. 含有ガス量 (ガス量測定装置GV-700 [試管-018]) ガス量測定: ダ品試 42003-D3 による
目 的		2. 発生ガス成分(ガス分析装置AG-1(TF-TRD)) ガス分析: ダ品試 42003-D3-1 による

表1.ガス量測定結果 含気量測量結果

試料	測定質量 (g) 試料質量	全ガス量 (ml) 总含気量	ブランク値 (ml) 等級値	含有ガス量 (ml/100g) 含気量
①	73	10.71	8.41	3.15
②	81	18.95	8.41	13.01
③	59	13.18	8.41	8.08

測定時間:30分

表2. 発生ガス分析結果 产生气体分析結果

試料	発生ガスの分析結果[発生ガスの割合%] 产生气体的分析結果 (产生气体的比例)							
	O <sub>2</sub>	N <sub>2</sub>	H <sub>2</sub>	C <sub>2</sub> H <sub>6</sub>	CO <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	CH <sub>4</sub>	CO
①	0.0	13.7	9.1	5.5	47.4	7.1	16.0	1.3
②	1.1	50.6	15.0	6.1	9.7	3.1	13.2	1.1
③	1.5	45.9	15.4	5.3	12.5	4.6	13.5	1.1

※N<sub>2</sub>、O<sub>2</sub>、H<sub>2</sub>は鑄造時のエア-や水分の巻き込みであると推察される。  
※CH<sub>4</sub>等Oを含んだガスの発生はチップ潤滑油などが原因と推察される。

Gas content tested in Japan



## 4 Summary

- 1 A novel multi-channels high vacuum die casting technology, including vacuum valve, vacuum system, sleeve lubrication and seal etc, was developed. It owned high venting speed and higher vacuum level of the die cavity.
- 2 High vacuum die casting of front sub-frame was researched. The gating system was optimized through Magma software.
- 3 The mechanical property of casting made by high vacuum die casting can meet the specifications. Gas content tested in Japan is lower than 15cc/100g nearby overflows and 10cc/100g nearby ingates.



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---

**TITLE**

Low Pressure Casting

A traditional casting technology helping to step ahead for light weight solutions in engine block manufacturing

**ABSTRACT**

Lightweight construction is currently a dominant theme in the automotive industry. The latest emission standards and CO2 fleet requirements of governments are forcing our customers to find new ways to reduce the weight of the vehicle. This ranges from lighter, yet more stable crankcases via weight-optimized chassis parts.

Today new developments in the field of sand core production, casting machines and process technology allow structural parts and crankcases to be produced with the low-pressure casting.



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**Asia 2015** 6<sup>th</sup> - 8<sup>th</sup> of Jul

AUTOMOTIVE LIGHTWEIGHT

# PROCUREMENT SYMPOSIUM

Jumeirah Himalayas Hotel in Shanghai, China

## Low Pressure Casting

**A traditional casting technology helping to step ahead for light weight solutions in engine block manufacturing**

## Agenda

- 1. Short introduction – Who is Kurtz?**
- 2. General Topics and motivation to use LPDC**
  - Motivation
  - Casting process – Low Pressure Casting
  - Cost pressure
  - Process as a whole
- 3. Layouts Casting Lines from experience**
- 4. Application regarding light weight construction**
  - Properties cast parts
  - Productivity
  - Sand core technology
    - Type of sand cores
    - Core handling
- 5. Summary and prospects**

## 1. Who is KurtzErsa?

### Electronics Production Equipment



Stencil printers



Reflow ovens



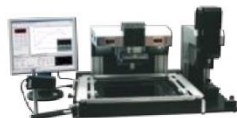
Wave and selective soldering systems



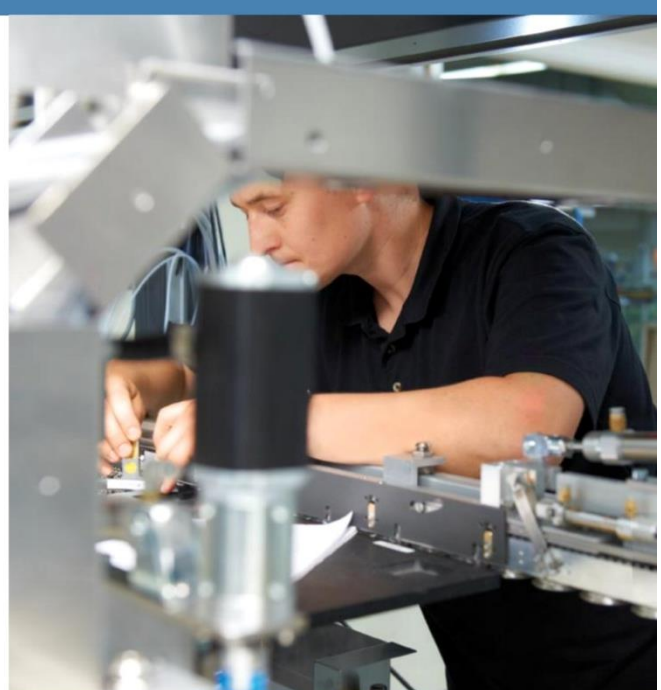
Inspection systems



Hand soldering stations



Rework systems



## Metal Components



Permanent  
mould aluminium castings



Grey/nodular cast-iron



Sheet metal technology



Machining



## Moulding Machines



Shape  
moulding machines



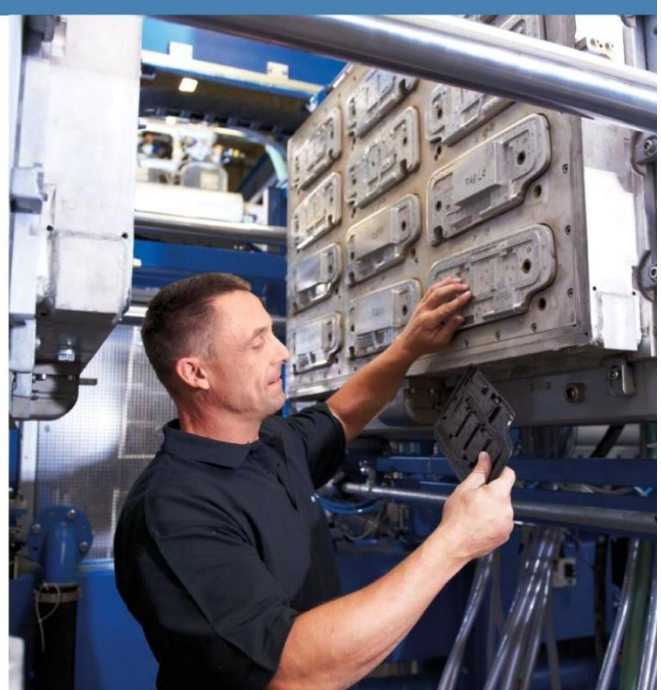
Block moulds



Low-pressure  
casting machines



Trimming presses



## Trimming Presses



**KPS 3000 SKT**



**KPS 1000**



**KPS 500**



**KPC 520**

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## KURTZ Low Pressure Casting Machines



**AL 10-7 SC**



**AL 14-10 SR**

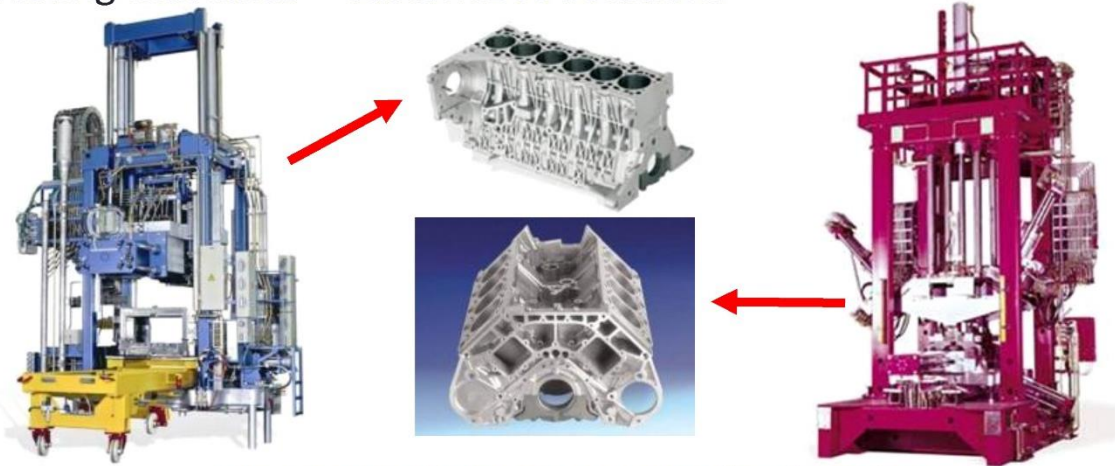


**AL 13-13 FSC with furnace shuttle**

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## LP-Casting Machines – Customized Solutions

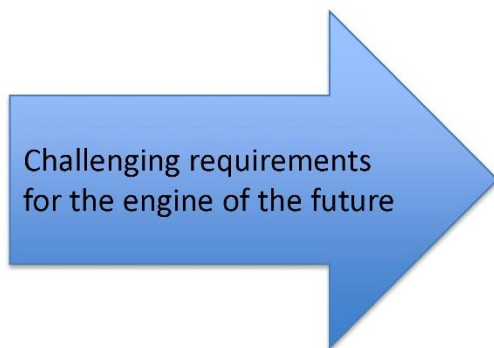


Following engine blocks are cast on KURTZ foundry machines:  
BMW F1 – Racing, BMW V8, V10 and V12, Porsche V8 - Sports utility vehicle; Audi V6 and V8,  
BMW R6 Diesel, VW R5 and V10 Diesel, Jaguar V8,  
Land Rover V8

## 2. General Topics and motivation to use LPDC in engine block casting

- Motivation
- Casting Process – Low Pressure
- Cost pressure
- Process as a whole

## Motivation of our customers



- downsizing
- high power and torque requirements
- Increased thermal requirements
- Increased mechanical requirements
- Emissions behavioral improvement
- Reduced fuel consumption

## Motivation

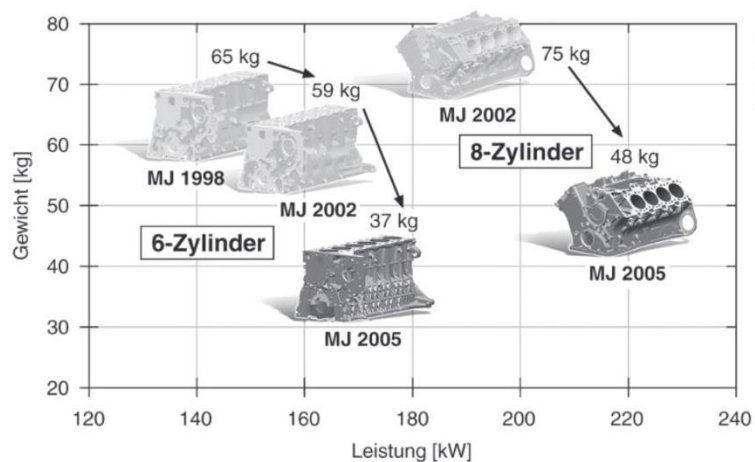


Bild 5: Entwicklung BMW Diesel Kurbelgehäuse-Gewicht und Motorleistung bis 2005 [3].



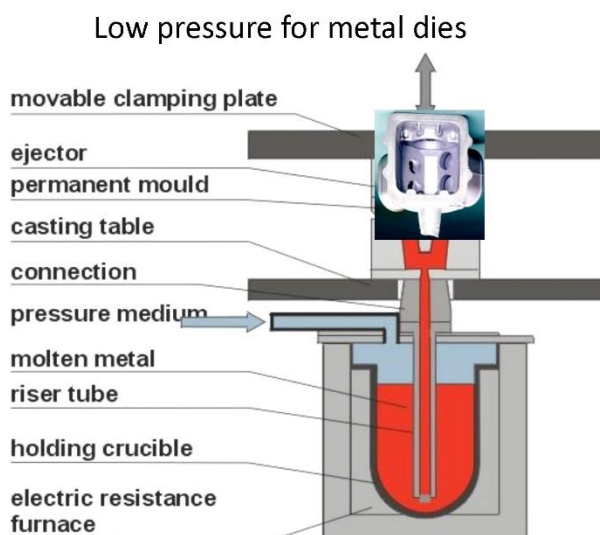
Pictures and graphs are courtesy of BMW



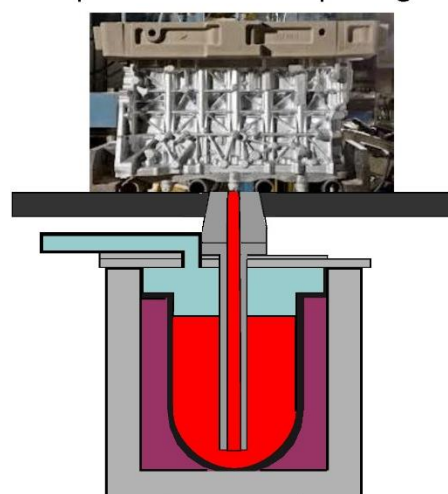
## Requirements of machine- and process development

- Developing of inorganic core binder systems
- Developing of a special casting process with the use of low pressure machines – low pressure filling with gravity solidification
- Developing highly efficient LPDC machines and casting lines
- Special casting line concepts for highest Al material cleanliness

## Basic Concept of Low Pressure Die Casting



Low pressure for sand packages



## Advantages and Benefits of Low Pressure

- ❖ **Controllable filling of the mould**  
filling against gravity force
  - no turbulence
  - less oxide films
  - better mechanical properties
- ❖ **Feeding Pressure**
  - better mechanical properties
  - 1bar feeding  $\triangleq$  6m height (Mg)
  - 1bar feeding  $\triangleq$  4m height (Al)
- ❖ **Metal is kept within a closed vessel**  
metal bath surface not disturbed or ruptured → cleaner material
- ❖ **Operation under a protected atmosphere** → no respectively low hydrogen content
- ❖ **Controlled solidification with pressurized furnace**  
higher yield than with conventional risers → higher yield
- ❖ **Highly automated process** → less human faults

## Comparison Gravity Die Casting – Low Pressure Die Casting

Example of yield:  
Comparison of gravity die casting and low pressure die casting

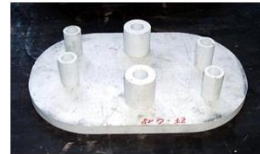
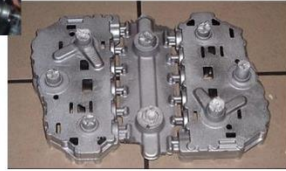
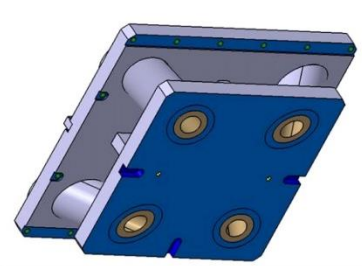
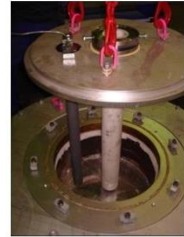
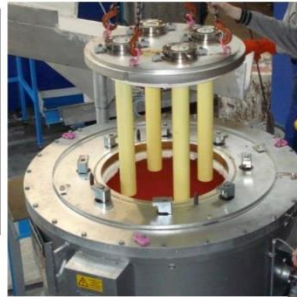


21,3 kg	Casting weight	12,2 kg
54%	Output	92%
7 pcs/h	Productivity	8 pcs/h

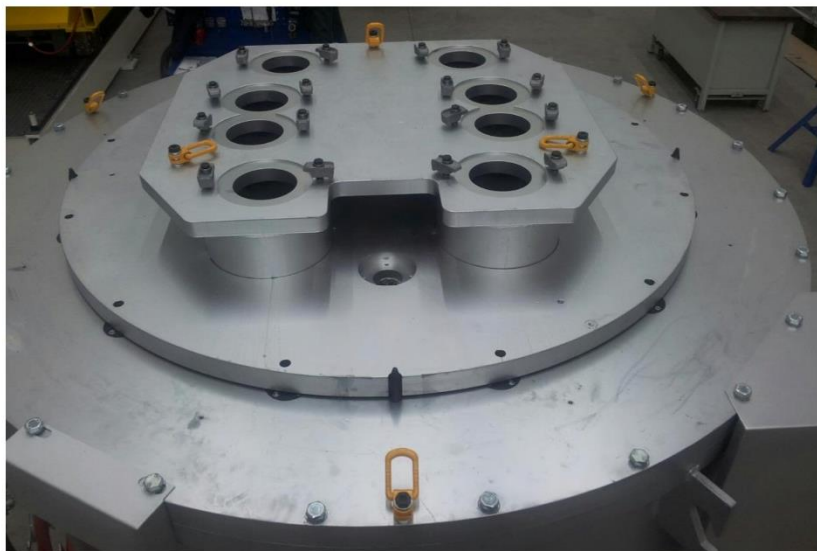
### Example

- 50,000 parts / year
- 9 kg / part saving cycle  
= 450,000 kg aluminum
- 7% melting loss = 31,500 kg
- Total weight 481,500 kg
- Melting costs per  
kg  $\emptyset$  0.50 € x 481,500 kg  
= 240,750.00 €

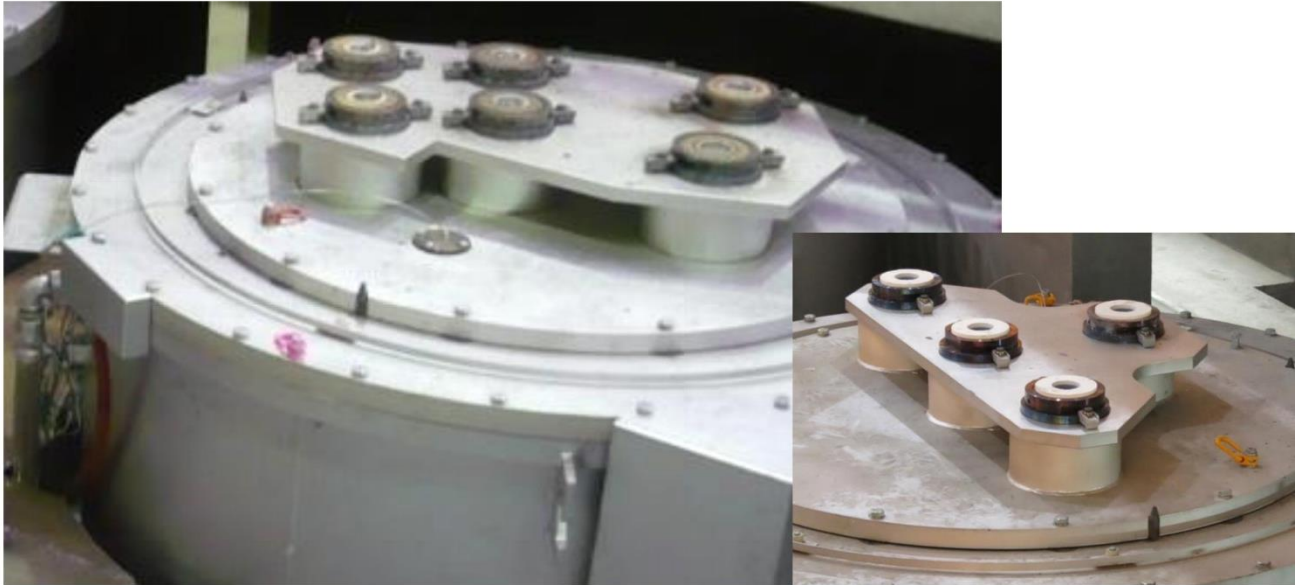
## Gating System



## Mold gating system



## Mold gating System – interface to the casting mold



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## New Machine concepts



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## Furnace change shuttles – 2800 kg Al



## Comparison Furnace Insulation: Low Pressure - Gravity



**Furnace Gravity**  
 open furnace without furnace cover  
 poorly insulated furnace cover

- ➔ Heat loss
- ➔ Energy loss

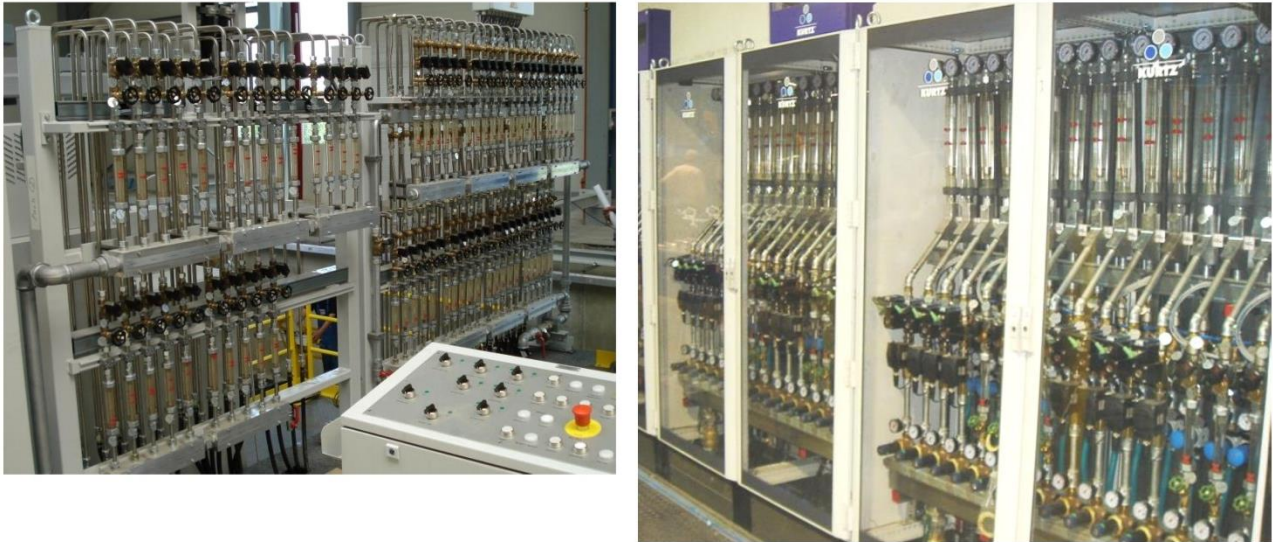
**Costs / Energy saving due to furnace insulation**  
 Reduction of energy costs by 40 - 50 %  
 Savings per year:  
 approx. 50.000,- € 300 kg furnace  
 6 x 2 furnaces in line



**Furnace Low Pressure**  
 closed furnace mit furnace cover  
 furnace insulation

- ➔ no heating loss
- ➔ energy saving

## Special mold cooling system – for optimized process control

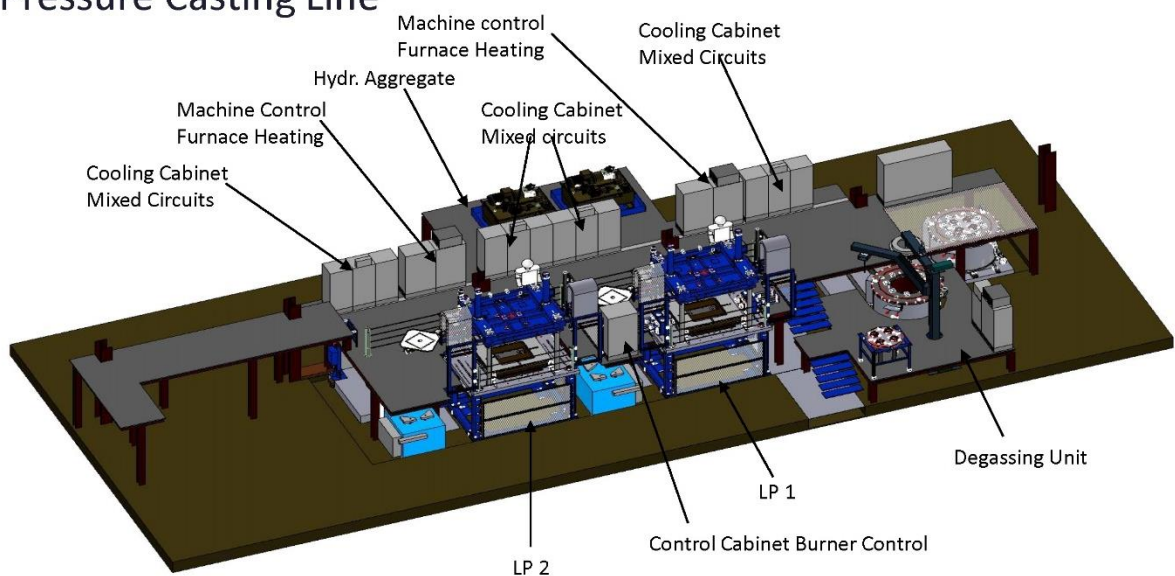


## Tool change system – for very quick mold change overs

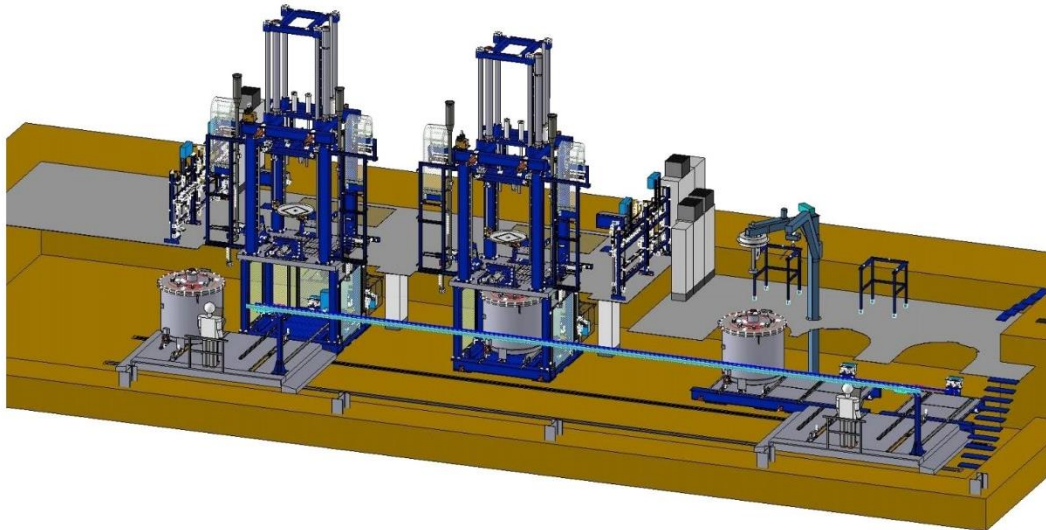


## 3. Layouts Casting Lines from experience

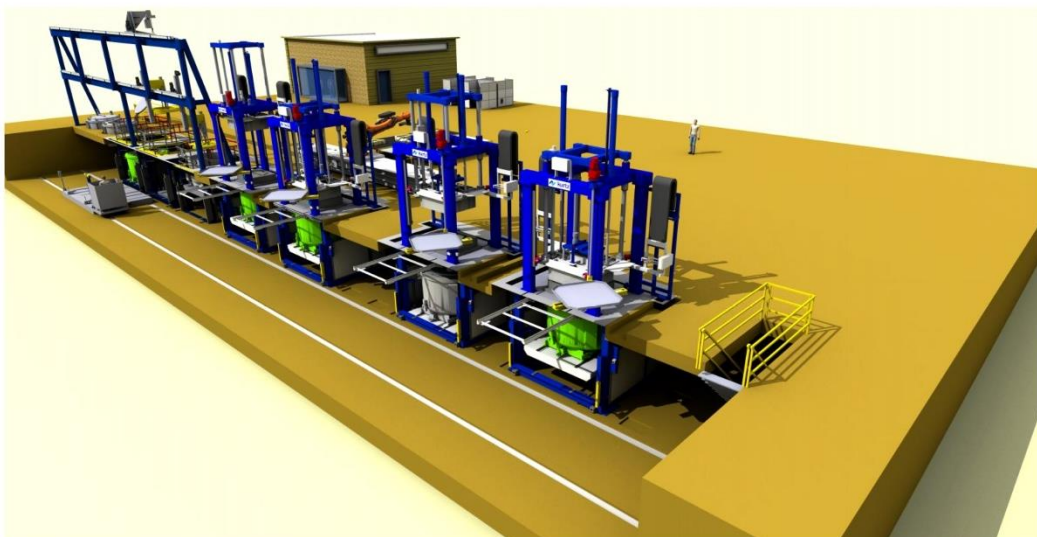
### Low Pressure Casting Line



## Low Pressure Casting Line

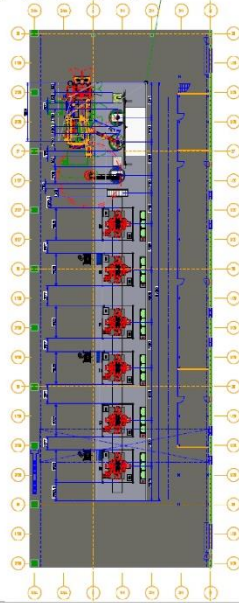


## Low Pressure Casting Line





## LP-Casting Line for OEM



## Automation

### Automation Tasks

- Core handling
- Insert sieves
- Casting removal
- Cleaning mould
- Cooling
- Marking with plausibility check
- Peripherals
- Unloading



## 4. Application regarding light weight construction

- Properties cast parts
- Productivity
- Core technology
  - Type of cores
  - Core handling

### Structure Part Side Beam for Al-Car Body

Serial:  
Side beam,  
complex cast with cores  
LP-Die-Casting  
AlSi7Mg0,2 T6  
Wall thickness  $\geq 3,5$  mm

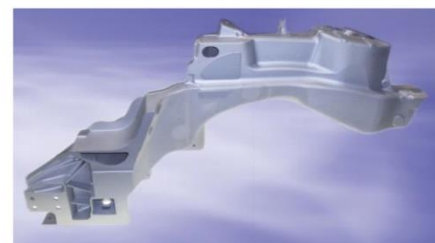
Mechanical Properties  
(critical areas):

$R_{p0,2} \geq 160$  N/mm<sup>2</sup>  
 $R_m \geq 240$  N/mm<sup>2</sup>  
 $A_5 \geq 12$  %

Main Characteristics:

- Large dimensions
  - 1200 mm
- Thin walls
  - Actual 4 mm
  - Aim  $\geq 2,5$  mm
- High ductility
- High yield strength

1200 x 800 / 20kg



Source: Martinrea Honsel Germany GmbH



## Low Pressure WITH Sand Core / Suspension Part

**Product:** knuckle le/ri  
**Model:** Porsche Panamera  
**Process:** Low pressure die casting, 4 cavities  
**Scope:** Core making, casting, de-coring, trimming, sawing, heat treatment, processing  
**Alloy:** AlSi7Mg; 4,35 kg



**Source:** Georg Fischer Kokillenguss GmbH,  
Herzogenburg, Austria

**+GF+**

## Mechanical Properties Knuckle

### Knuckle Porsche Panamera - Sandcore

#### Yield Strength

Target: 220 MPa      Actual: 222-260 MPa

#### Tensile Strength

Target: 260 Mpa      Actual: 288-336 MPa

#### Elongation

Target: 6 %      Actual: 6-12 %



### Knuckle Audi B8 – no cores

Target: 220 Mpa

Actual: 239-286 MPa

Target: 280 MPa

Actual: 305-343 MPa

Target: 5 %

Actual: 5-14 %



**Source:** Georg Fischer Kokillenguss GmbH,  
Herzogenburg, Austria

**+GF+**

## Low Pressure / Suspension Part

**Product:** Querbrücke  
**Model:** Porsche Panamera  
**Process:** Low pressure die casting, 2 cavities  
**Scope:** Casting, trimming, sawing, heat treatment, processing  
**Alloy:** AlSi7Mg; 6,1 kg



**Source:** Georg Fischer Kokillenguss GmbH,  
Herzogenburg, Austria

**+GF+**

## 5. Summary and Prospects

## Summary

- **Light weight construction / Core casting**
  - One cast part replaces several sheet metal parts which have to be joined together
  - Weight reduction
  - Profitably
- **Part geometry**
  - Dimensions of known suspension parts up to structural parts
  - Larger and more complex
  - Core technology– anorganic cores
- **Plant designs**
  - Casting machines and furnaces become larger
  - Multiple cavity 4- up to 8-cavities
  - Riser tube/ gating concepts more complex
  - More cooling and controlled
  - Melting/ furnace logistics

## Reasons for low pressure casting

- **Casting requirements**
  - Mechanical properties
  - Elongation
- **Economical**
  - Cycle material
    - Profit by reduced energy costs – melting down
    - Profit by „Return cycle material – Recycling“
  - Cycle time – multiple cavities
- **All round part concept**
  - Easier way from cast part up to finished part
  - Less post-processing
- **Plant concepts / Investments**
  - The bottom line is economical!
  - Will stand every competition!

## Prospects

- Leight weight construction / core casting as promising casting
- Tailor-made universal machines in large format
  - NO CONTRADICTION
  - Cycle time – multiple cavity
- Low pressure as intelligent concept
  - Classic low pressure casting
  - Low pressure casting combined with gravity casting
  - Cycle time by multiple cavity unbeatable
  - MORE than competitive compared to low pressure and high pressure die casting

**Thank you very  
much for your  
attention!**



# voestalpine

EINEN SCHRITT VORAUS.



**Mr. Peter Bernscher**  
**Member Of The Board &**  
**Director Automotive Body Parts**

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## TITLE

**Lightweight Solutions In The Automotive Industry By Voestalpine**

## ABSTRACT

Lightweight design will play an increasingly central role. The right material in the right place is essential. In vehicle high- and ultrahigh-strength steels, aluminum, plastics and hybrids are gaining in importance. The future of lightweight construction in the automotive industry are different concepts of a mix of materials, depending on the volume and price structure of a vehicle but always driven by increasing safety and efficiency targets. The Metal Forming Division of voestalpine now works with various materials. The largest contribution to the lightweight is undoubtedly in the steel sector (phs-ultraform steels), but also aluminum and hybrid components are an issue. Voestalpine is constantly working on new lightweight solutions, not only for the automotive sector but also for other industrial segments.

## Lightweight Solutions in the Automotive Industry by voestalpine

Peter Bernscher  
Shanghai, 7<sup>th</sup> July 2015

**voestalpine**  
ONE STEP AHEAD.

### voestalpine Activity Overview



Steel	Special Steel	Metal Engineering	Metal Forming
Top European Player	Global Leadership	Global Leadership	Global Top Player
Top-three European supplier of high quality sheet and global top position in heavy plate for the most demanding applications.	Worldwide leader in tool steel. Leading position in high-speed steel and special forgings.	European market leader for rails and processed wire, world market leader for turnouts and complete railway systems; leading position in welding consumables and seamless tubes.	Leading worldwide supplier of high-quality metal processing solutions, in particular special sections and precision steel coil as well as complex components for the automobile industry.



## voestalpine in Figures Overview

### Key figures for 2014/15

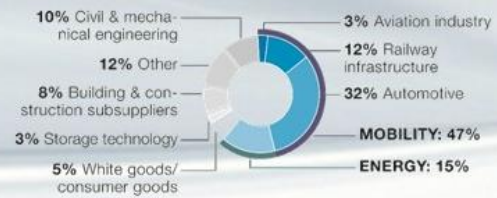
Employees	47,418
Revenue	EUR 11,189.5 million
EBITDA	EUR 1,530.2 million
EBIT	EUR 886,3.3 million
EBIT margin	7.9%

500 Group companies and locations in more than 50 countries and on all five continents.

### Revenue by regions (Business year 2014/15)



### Revenue by industries (Business year 2014/15)



## Why Lightweight Design?

### General Requirements

CO<sub>2</sub> Emission



Weight reduction



Economy / Costs

### Customer Expectations

Safety

Comfort

Protection of Environment

Durability

Short Lifecycles

Standardization

Safety Regulations

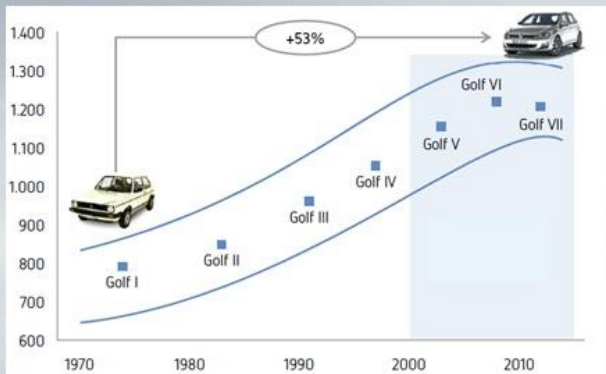
LCA

Overall Performance



## Increase in Vehicle Weight

Vehicle weight by generation comparison  
kg, standard equipment, Basic performance



Source: Berylls Strategy Advisors

Increased weight due to additional content over the years

- Significant weight drivers were
  - Size growth (length, width)
  - Passive Vehicle Safety (NCAP)
  - Comfort functions (new, series)
  - Expectations in driving comfort and dynamics (incl. Electronic Control systems)
  - NVH behavior

The Golf VII was the first model to break the pattern of increasing vehicle weight.

- Intensive construction, lightweight (Body structure)
- Chassis optimization

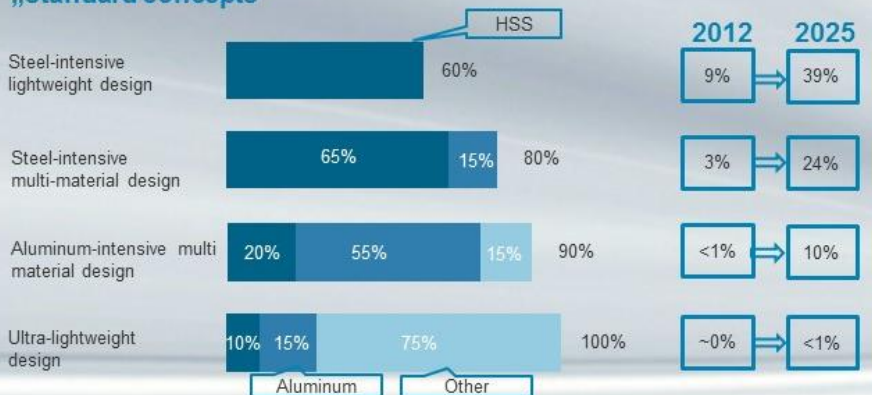
**Compensation of additional vehicle content through lightweight solutions "right across the vehicle".**

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## Development of Material Mix

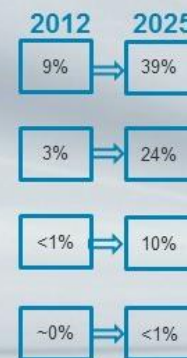
In the mid-term, archetypal „standard concepts“ with a growing share of lightweight design and a different material mix will emerge for the body.

### Share of lightweight design by „standard concepts“



HSS includes high-strength steel (HSS), advanced high-strength steel (AHSS), ultra-strength steel (UHSS)

### Market share



### Examples



Source: Berylls Strategy Advisors

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## Lightweight Design by voestalpine

- The driving force of lightweight development within voestalpine group is linked to the automotive industry.
- The Metal Forming Division of voestalpine is working with different materials since 15 years.
- The greatest contribution comes from the steel side (phs-ultraform steels), but also aluminum and hybrid components are an issue.
- voestalpines advantages start with steel, which form the basis for various lightweight structures. The development of new steels is far from exhausted and "3. Generation" steels open more diverse potentials.
- Lightweight potential can be not only found in cars, but also in planes, commercial vehicles, cranes, containers, railway cars and agricultural and construction machinery as well as in many other products.
- In addition, innovative design and joining techniques enable additional weight saving.

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## Turnover with Lightweight Design in Mio € by divisions and industry segment

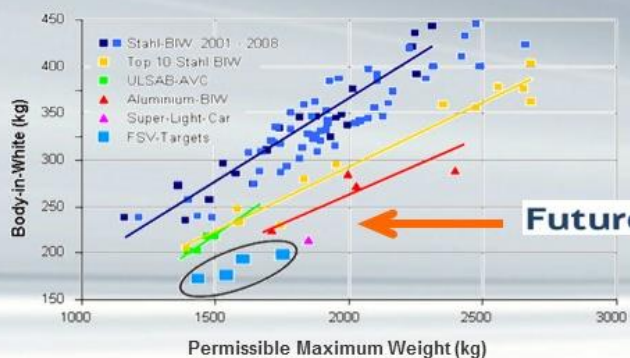
	Cars	Commercial Vehicles	Building Industry	Energy	Aviation
Steel	690	50			
Metal Forming	430	40	100	20	20
Special Steel	180 <small>Tooling material</small>				280
Metal Engineering	200			100	
<b>Sum: 2.110</b>	<b>1.500</b>	<b>90</b>	<b>100</b>	<b>120</b>	<b>300</b>

8 Shanghai, 7th July 2015

## Overview Lightweight Design: Steel by voestalpine

### Steel: The Weight-Watcher

- Project of 17 steel producers, among them voestalpine, as part of WorldAutoSteel
- Configuration of 4 vehicles of different size and 3 drive systems
- Design of a lightweight body for an electrical vehicle of 190kg



## Steel: The Weight-Watcher

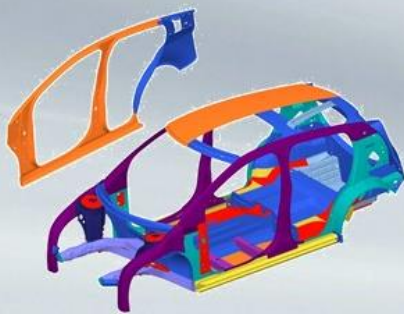


Vehicle	BIW Mass (kg)	Length (mm)	Width (mm)	Height (mm)	Wheelbase (mm)	Track Frt/Rr (mm)	Powertrain Mass (kg)	Curb Mass (kg)	Payload (Max)	GVW (kg)	Plan View Area (m <sup>2</sup> )
FSV	190.7	3820	1705	1495	2524	1470	328.7	958	475	1433	6.51
BMW i3	269.8	3999	1775	1597	2570	1572	447.3	1297	425	1722	7.10

Mass of Body Structure

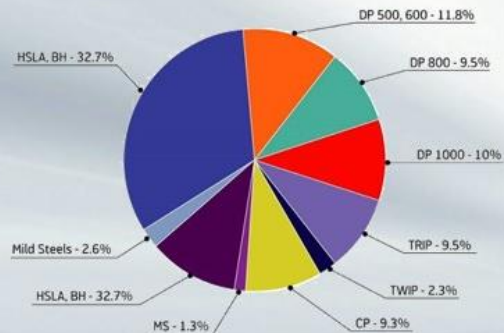
$$m = 1.0437(\text{GVM kg})^{0.546} (\text{Area m}^2)^{0.579} \begin{bmatrix} 1.00 \text{ Aluminum} \\ 1.443 \text{ FSV - AHSS} \\ 1.524 \text{ Steel} \end{bmatrix}$$

## Steel: The Weight-Watcher

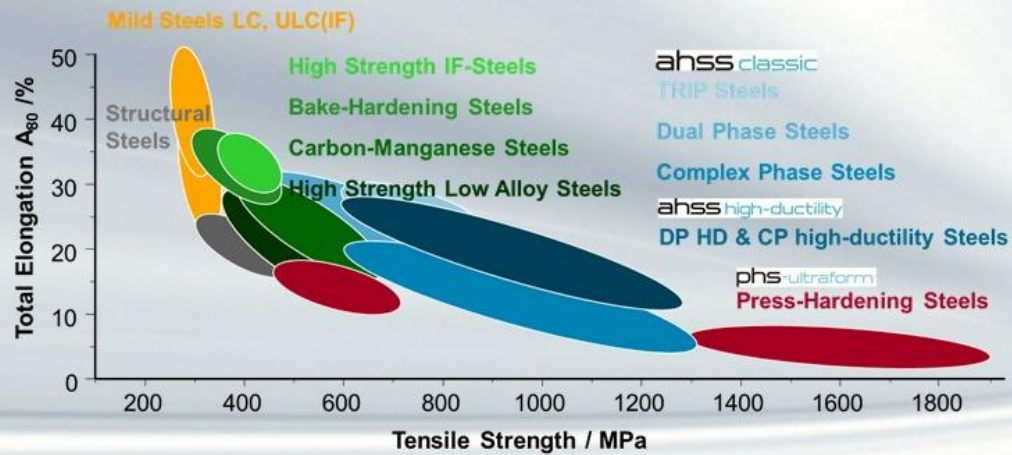


Weight reduction: 35% or 102 kg

FSV BEV Steel Types  
as % of Body Structure Mass



## Steel grades by voestalpine



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## Coldforming

### Highest strength steels for lightweight car body production

Lightweight construction through increased use of high-strength and ultra high strength steels

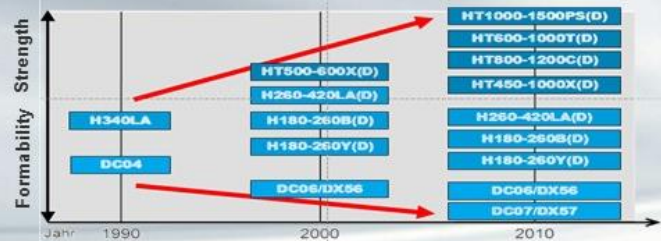
- Use the right materials in the right places by application-optimized material design
- Dual-phase and TRIP steels for deep-drawn parts.
- Complex-phase steels for section and bending type parts.



Complex-phase-Steel



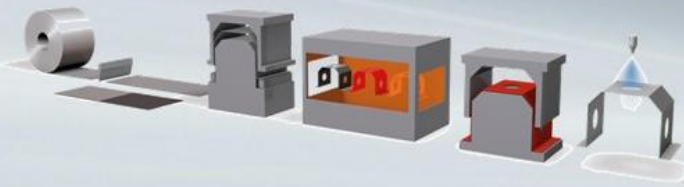
TRIP-Steel



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## Hotforming pHS-ultraform

### Indirect Process



### pHS-ultraform Advantages:

- Strength appr. 1800 N/mm<sup>2</sup>
- Complex geometries
- Cathodic corrosion protection
- Tight tolerances
- Tailor-welded blanks possible
- Partial hot formed parts
- Weight reduction
- Thickness reduction
- Large parts possible (2.8 x 1.4m)

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## Hotforming pHS-ultraform Tailored Property Parts



Hardened

Tailor welded  
blank

Patch inside /  
Patch outside

Annealed

Tailored tempering  
(local)

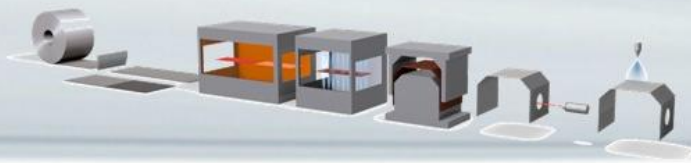
- Hardened = 1500 or 1800 MPa
- Partner material HT490 = 500 MPa
- Tempered < 1500 MPa
- Initial hardness = 500 MPa

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## Hotforming pht-directform

- Direct process for zinc-coated material: Technology is ready (Pre-cooling).
- Microcracks-problem solved.
- First serial production line in procurement.
- SOP March 2016

### Direct Process



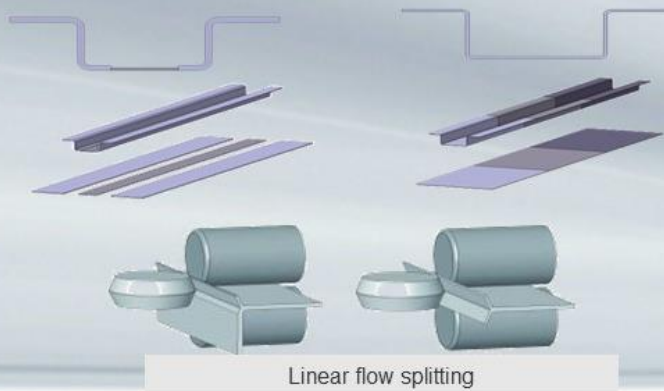
### pht-directform Advantages:

- Cathodic corrosion protection
- Only one tool necessary
- Optimized material use
- Low tool wear
- Existing direct hot forming lines are adaptable.
- Over 10 years experience with galvanized press-hardened steels.

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## Lightweight Design with Tubes and Sections

### Tailored Tubes



- Rollform Hardening
- Quenched & Tempered



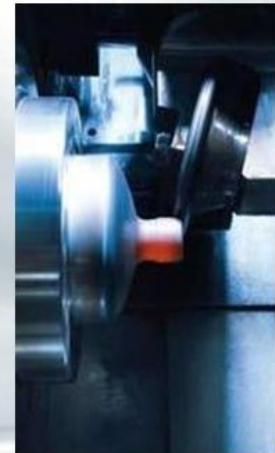
**Tailored Tubes and temperature-treated tubes and sections:  
Weight reduction through customized thicknesses and strengths.**

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## Rotational Forming

- Local material hardening and different wall thicknesses over component length allow application-specific component design.
- Production of rotationally symmetrical parts
  - Processing of C and stainless steel, aluminum, copper
  - Rotary swaging and round forging
  - Rotational forming in cold, warm and hot state
- Elimination of welded seams (one formed part instead of several welded parts)
- Weight reduction: 10-15% possible.



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## Rotational Forming – Examples

Pressure Vessel for Air Suspension Systems – Aluminum or Steel:



Pistons for Air Suspension Systems - Aluminum or Steel



Various Vessels – Aluminum, Steel or Stainless Steel:



Airbag components

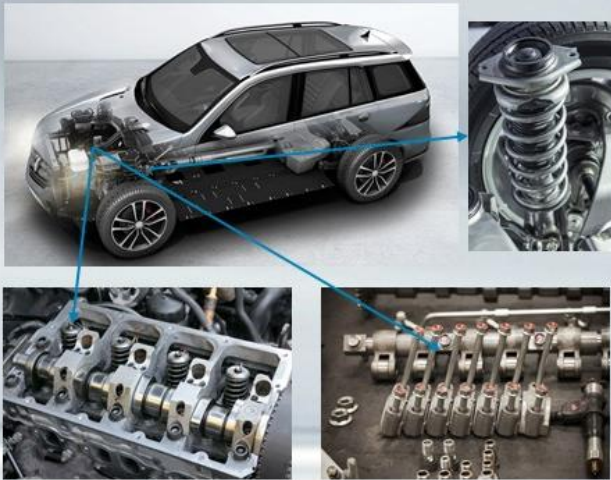


Avalanche airbag



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## Wire Solutions for Automotive Industry



Pre-material for multiple components -- e.g Spring and Bolts

- Large variety of micro-alloyed CHQ grades with tight strength range and optimized microstructure
- High purity steels for special end-use applications (e.g for highest fatigue applications)
- Ultra High Strength CHQ wires for UHT motor screws (e.g strength class 14.9 and higher)
- Using the of the Super Clean technology for highly dynamically loaded springs

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## Overview Lightweight Design: Hybrids, Aluminum and Other Materials by voestalpine

## Customized Semifinished Products

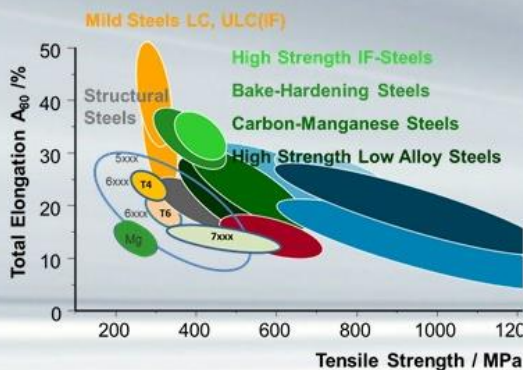
- Laser-Welded Blanks (Weight: -10-15%)
  - With continuous thickness transition
  - With variable thickness jump
  - With linear and non-linear seams
  - Aluminum/Aluminum welded blanks
- High-strength laser-welded blanks
  - phs-ultraform®
  - Multi-phase steels ( $R_m \geq 600$  MPa)
- Hybrid Blanks
  - Steel/Aluminum (weight: -30-40%)
  - Steel/Special steel
- Partial press hardening with phs-ultraform®



Potential for weight reduction of 10-35% by varying strengths and optimizing materials mix!

## Lightweight Metals used by voestalpine

- In comparison to steel
  - Reduced formability => cold forming, super plastic forming
  - Modified joining processes => welding, toxing, clinching, FDS
  - Modified painting processes => modified cataphoretic painting



## Aluminum Processing

- “Hot forming” of high strength AA7xxx (cooperation with AMAG and LCCR)

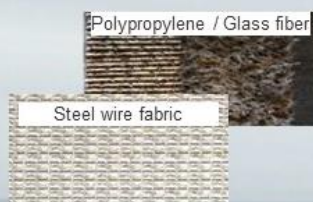


Side impact beam BMW i8

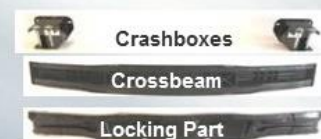
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## Plastics/Steel-Compounds

- Steel wire / Viscose– fabrics in Polypropylene / Glass fiber-Matrix
- High ductility and high strength
- Design freedom
- 15% less weight compared to aluminum concept



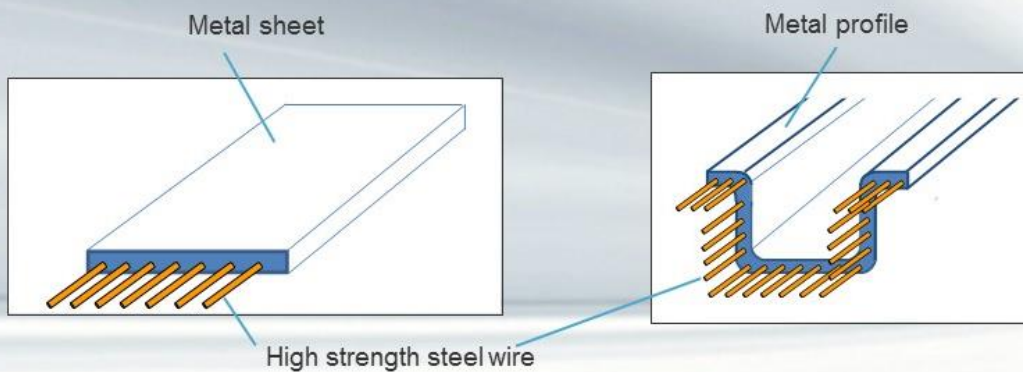
Quelle: AutoBild.de



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## Steel Wire Reinforced Metal

- Strengthening of metal blanks and structural components with high strength steel wire.
  - E.g. Aluminum with min. 45% increased tensile strength



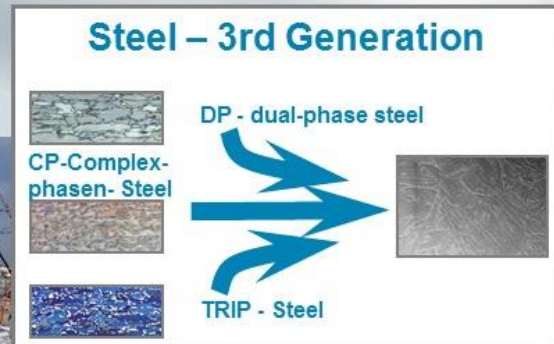
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Lightweight Design Innovation by voestalpine  
Other Segments

## Lightweight Design by voestalpine Non automotive

Building Construction  
Commercial Vehicles  
Mobile and Truck cranes  
Concrete pumps  
Railcars  
Containers  
Agricultural machinery  
Forestry machinery

Ultra-high-strength steel allows lightweight construction.



29 Shanghai, 7th July 2015

## Lightweight Design by voestalpine Non automotive

### Lightweight Railway Car

- Weight reduction of a freight car of
  - About 10% = 3 tons
  - Through high strength hot rolled strip



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## Lightweight Design by voestalpine Non automotive - Sustainability

Wind turbine gearboxes  
Growth of + 17% per annum



Substructures for solar and photovoltaic  
Systems: Weight reduction of 30%



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## Lightweight Design by voestalpine Non automotive – Aviation Industry

voestalpine supplies pre material and components for the aviation industry

- Rotor and power-unit components
  - Turbine plates, gear wheels
  - Rotor adjustments for helicopter



- Fuselage components
  - Aluminum frames



- Structural components
  - Flap track fairings
  - Engine mount structure



- Interior
  - Titanium seat rail



- Chassis components
  - Landing gear



32 Shanghai, 7th July 2015

## Lightweight Design by voestalpine Crane Constructions



### Seamless steel tube solutions for crane constructions

- Standard Q&T seamless steel tubes up to grade S890QL.
- ToughTubes® - thermo-mechanically rolled seamless tubes with high strength, excellent toughness and excellent weldability.
- Ultra-high strength thermo-mechanically rolled seamless steel tubes with yield strength > 1000 MPa + excellent toughness and weldability.

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## Lightweight Design by voestalpine Conclusion

- Global Footprint: Worldwide availability of modern (steel) materials and processes.
- Integrated value chain from steel pre material to the final assemblies and modules.
- Weight reduction potentials between 15-40% through modern steel grades and intelligent components development.

**Customers benefit from the extensive know-how in steel development as well as from construction knowledge with steel and alternative materials!**



34 Shanghai, 7th July 2015





## JSC AUTOMOTIVE



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### **TITLE**

**Outlook And Hurdles Of The Chinese Economy And Automotive Industry**

### **ABSTRACT**

China has become one of the most important markets for the automotive industry with fast growth rates. However, the automotive market in China is now going into a phase of slow growth and decreasing margins as the economy is slowing. China needs to rebalance its economy from relying too much on investment to more consumption. Major challenges have to be overcome like the dependence on real estate and the high debt load of the companies and the local governments. China will become either be caught in the middle-income trap or become rich with tremendous implications for the automotive industry.



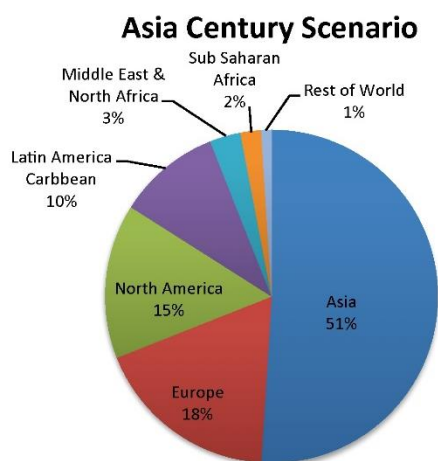
## Outlook and Challenges for the Chinese Economy and Automotive Industry

July 2015

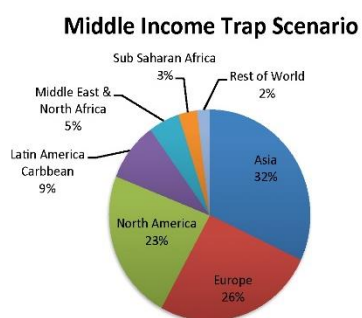
Alumag Symposium Shanghai

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### Two scenarios for Asia 2050

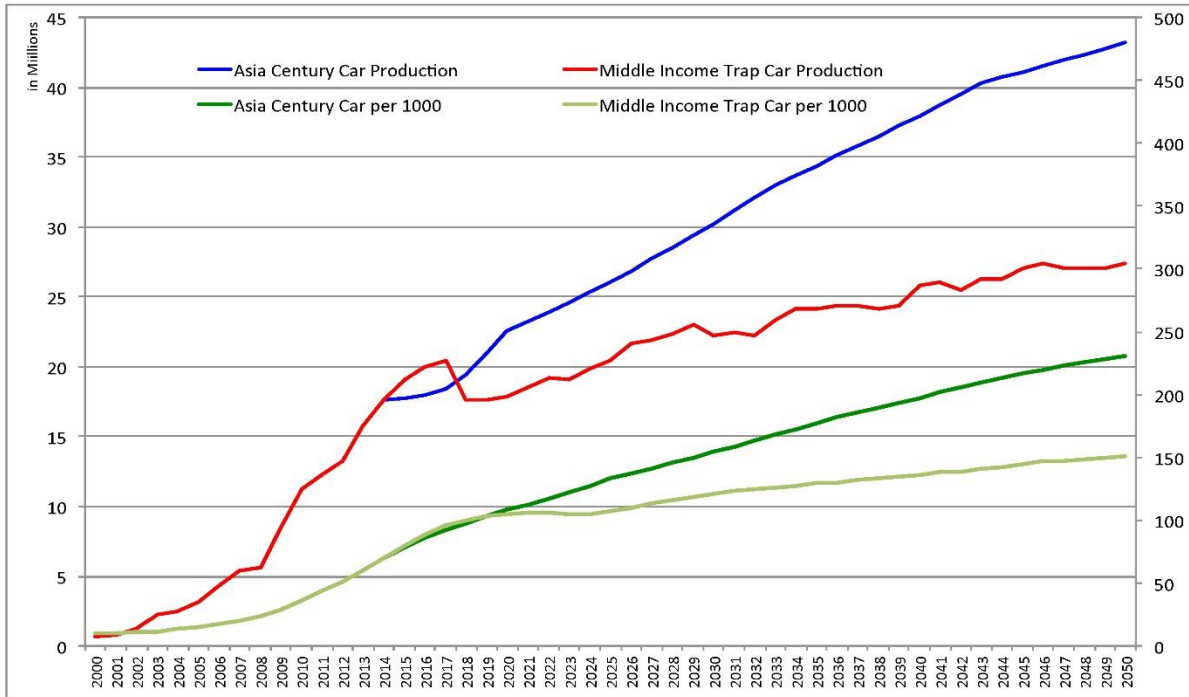


Asia GDP: US\$148 trillion

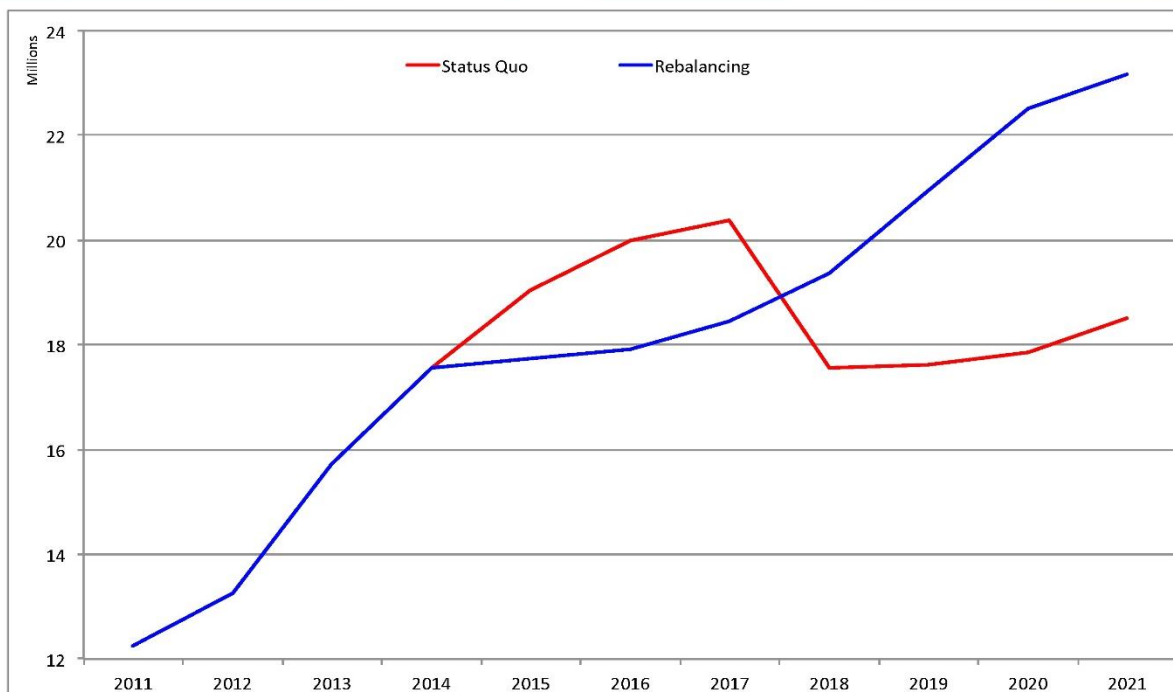


Asia GDP: US\$61 trillion

## Forecast Passenger Car until 2050: 2 Scenarios



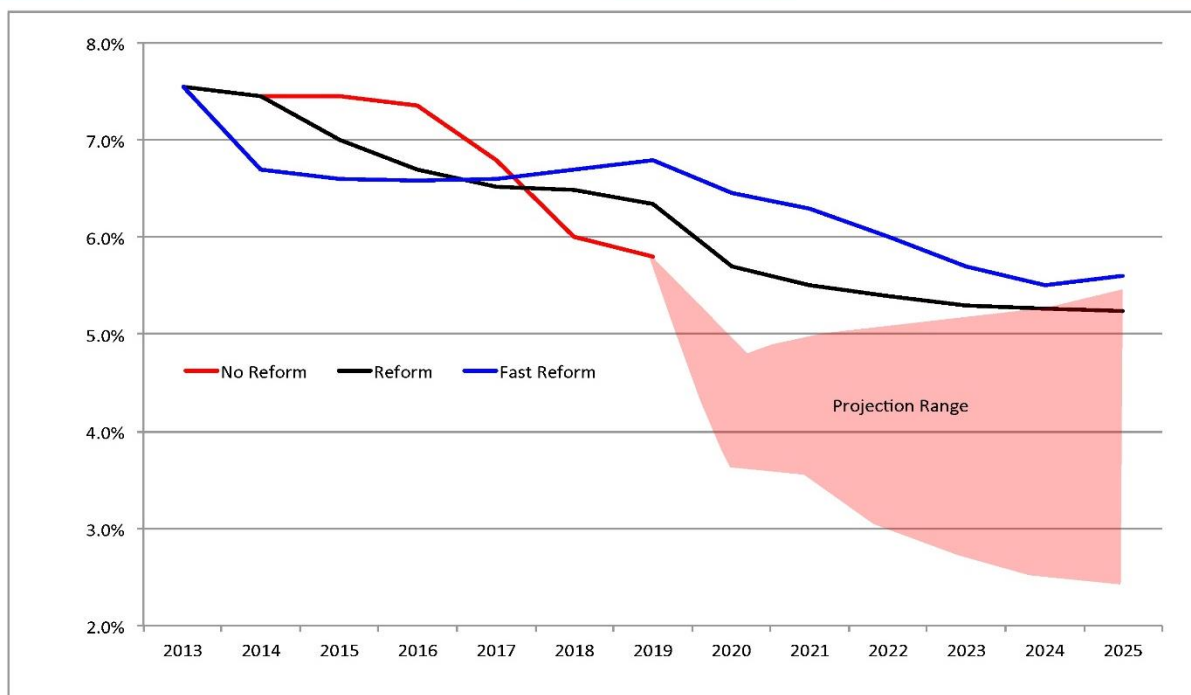
## Forecast Passenger Car until 2021



## IMF Report China July 2014

- The risk of a hard landing is low short term, but rises to medium in the medium term, should China not solve the main problems:
  - Real estate (including upstream and downstream now at 33% of the GDP growth!)
  - The corporations are highly leveraged
  - The local governments are in trouble financially
  - Banks NPLs are rising fast
  - Shadow banking getting out of control
- At the same time China must be careful with the implementation of the reforms. Otherwise a major crisis is possible, especially in case the real estate market undergoes a chaotic correction.

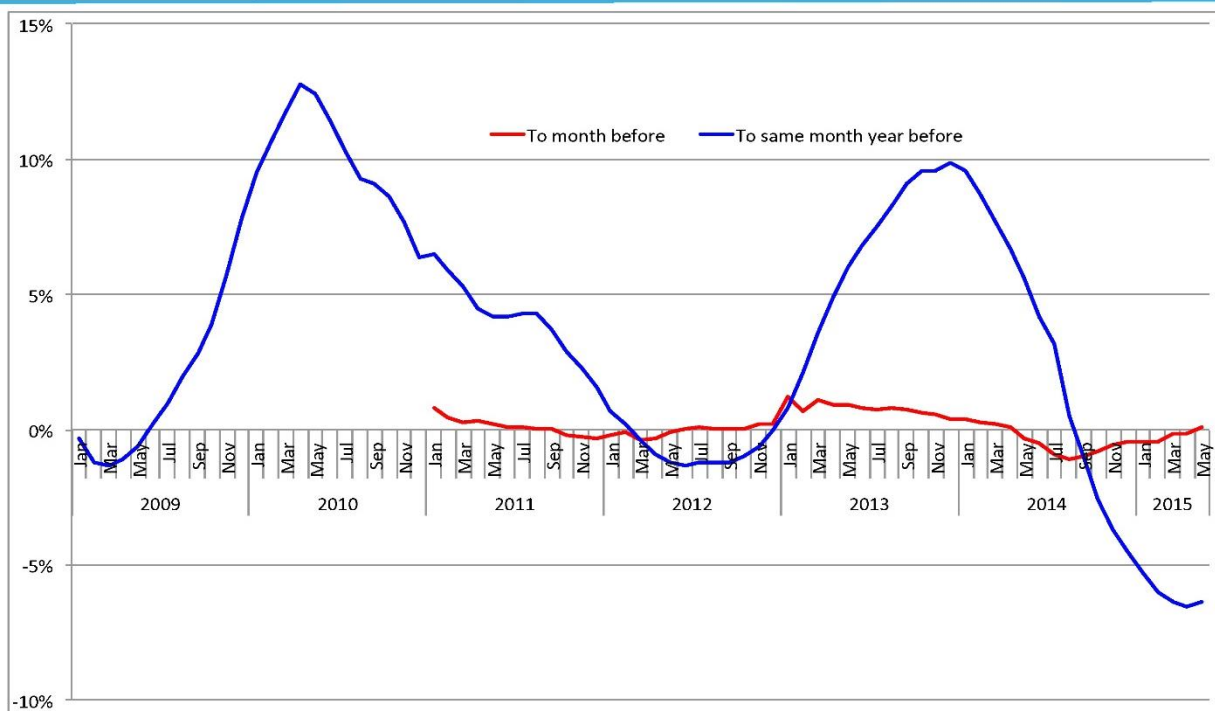
## Scenarios of the IMF for China



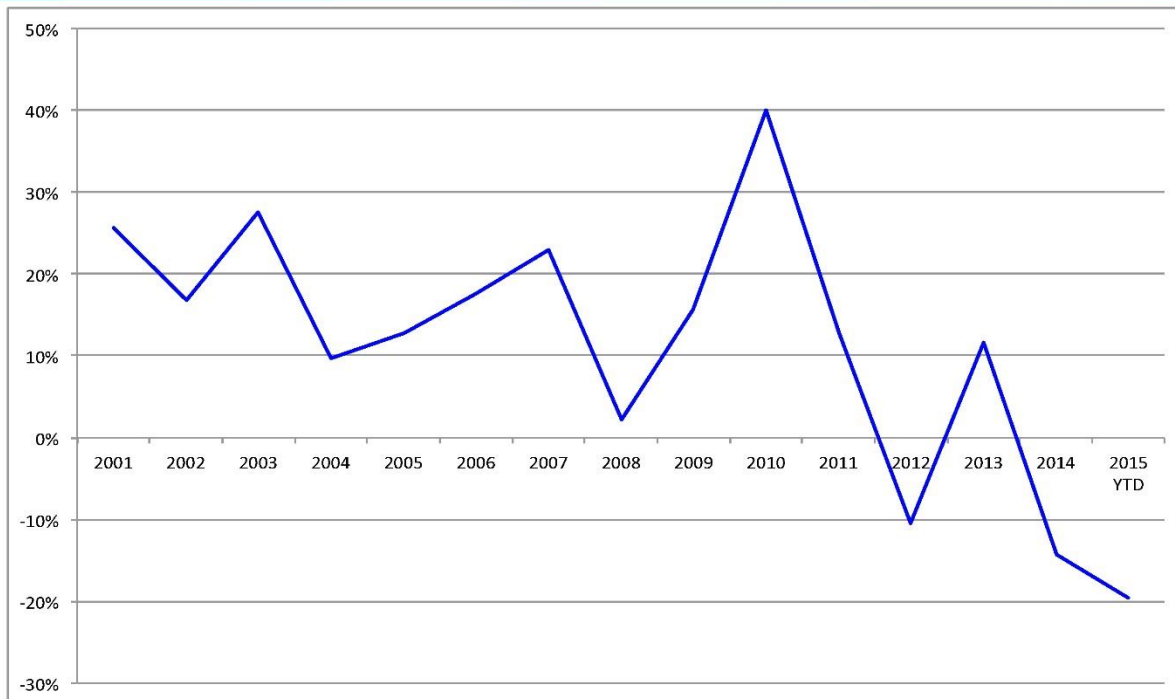
## The most important indicators for rebalancing

- 🕒 Interest rate liberalization
- 🕒 WMPs allowed to default
- 🕒 Liberalization of the banking system
- 🕒 Hukou reform
- 🕒 Better social security
- 🕒 Reform of the healthcare system
- 🕒 More funds into education

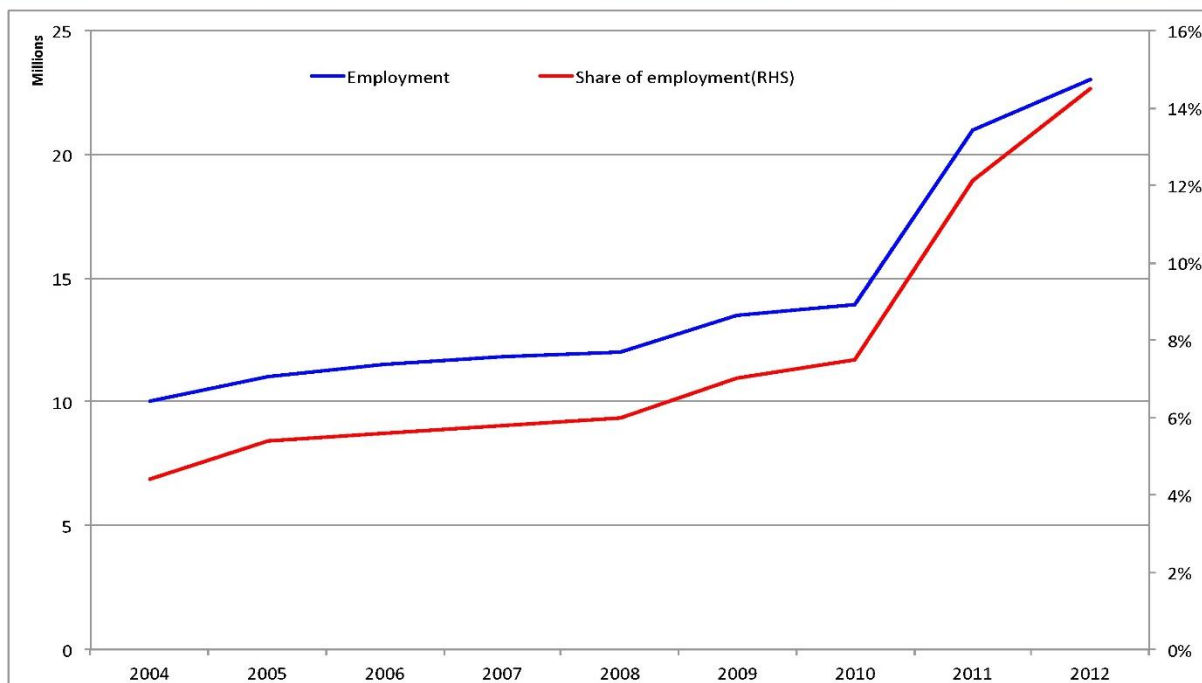
## House prices are falling: Red alert!



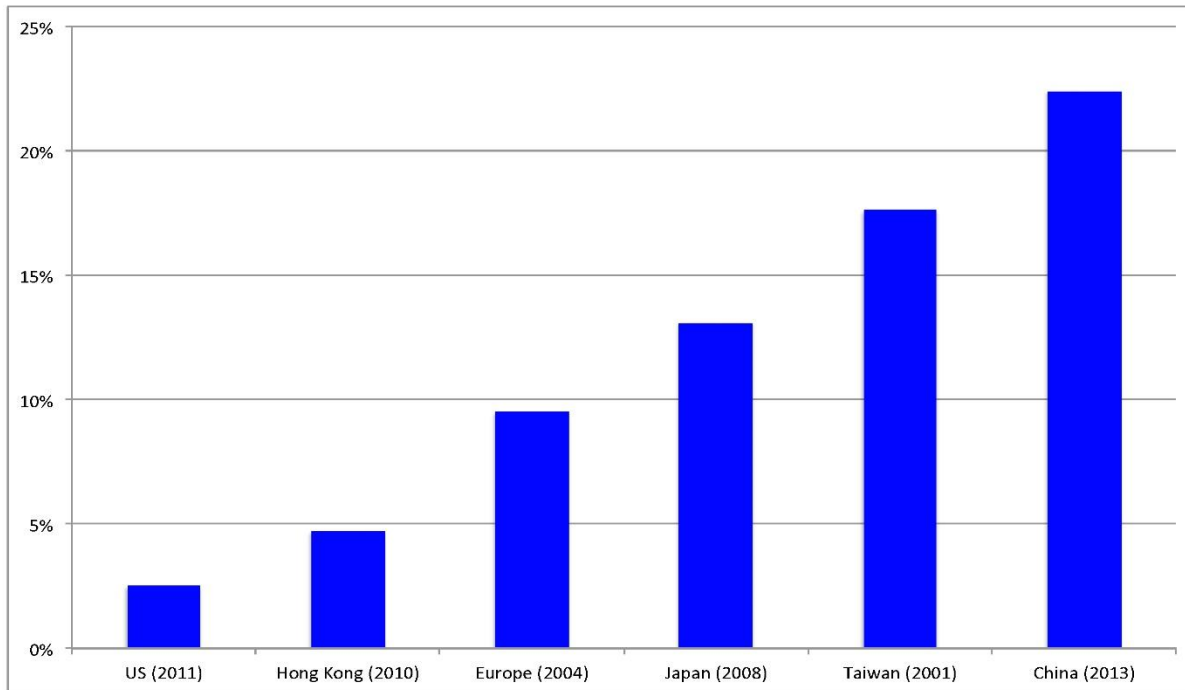
## The real estate industry is in trouble: Floor space starts are down



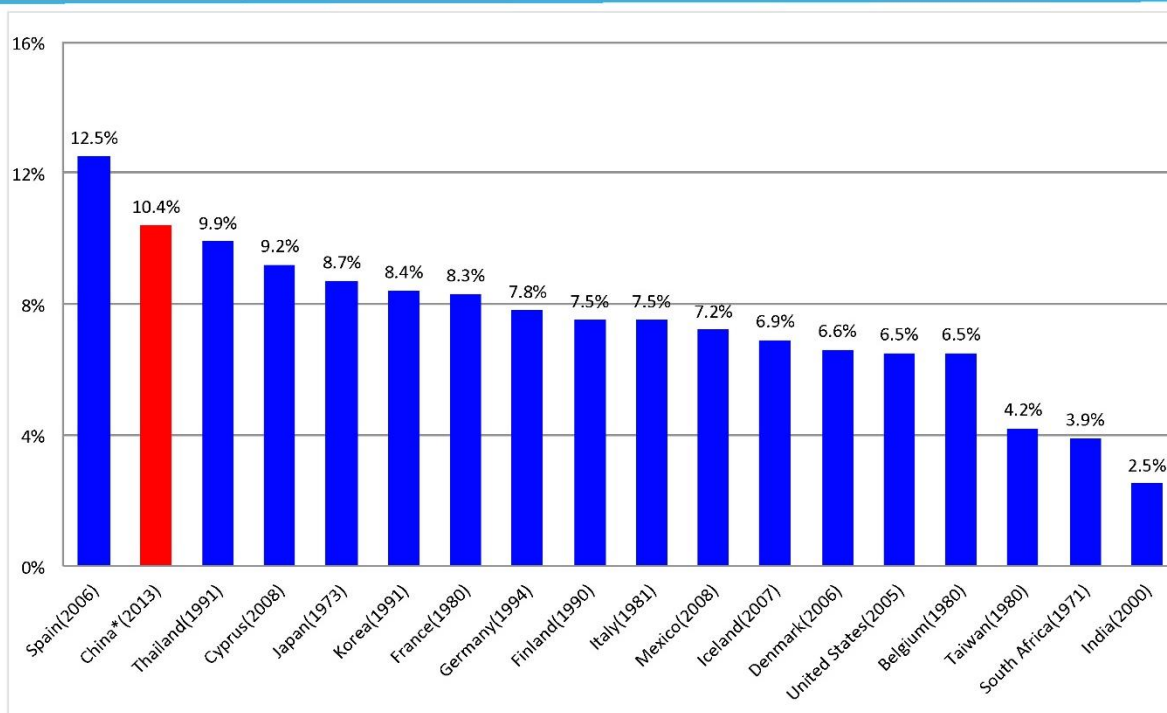
## There are almost 25 million employees in urban real estate



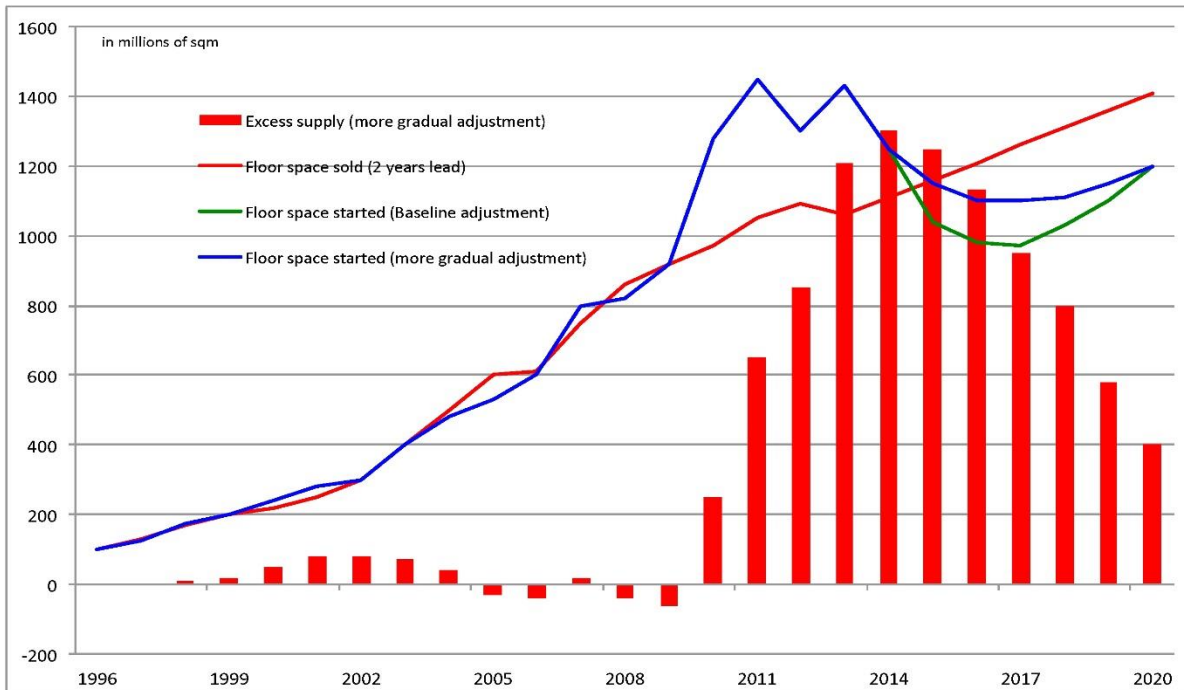
## Vacancy rates are extremely high



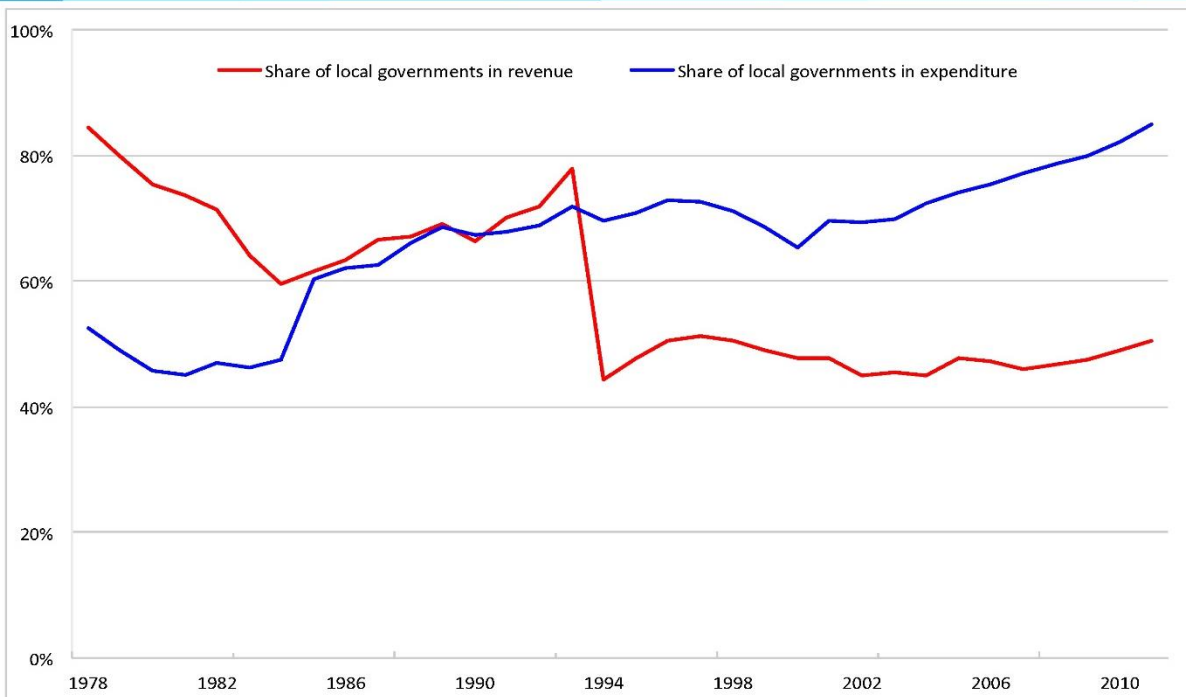
## Residential real estate to GDP factor extremely high



## Real estate not likely to recover before 2017

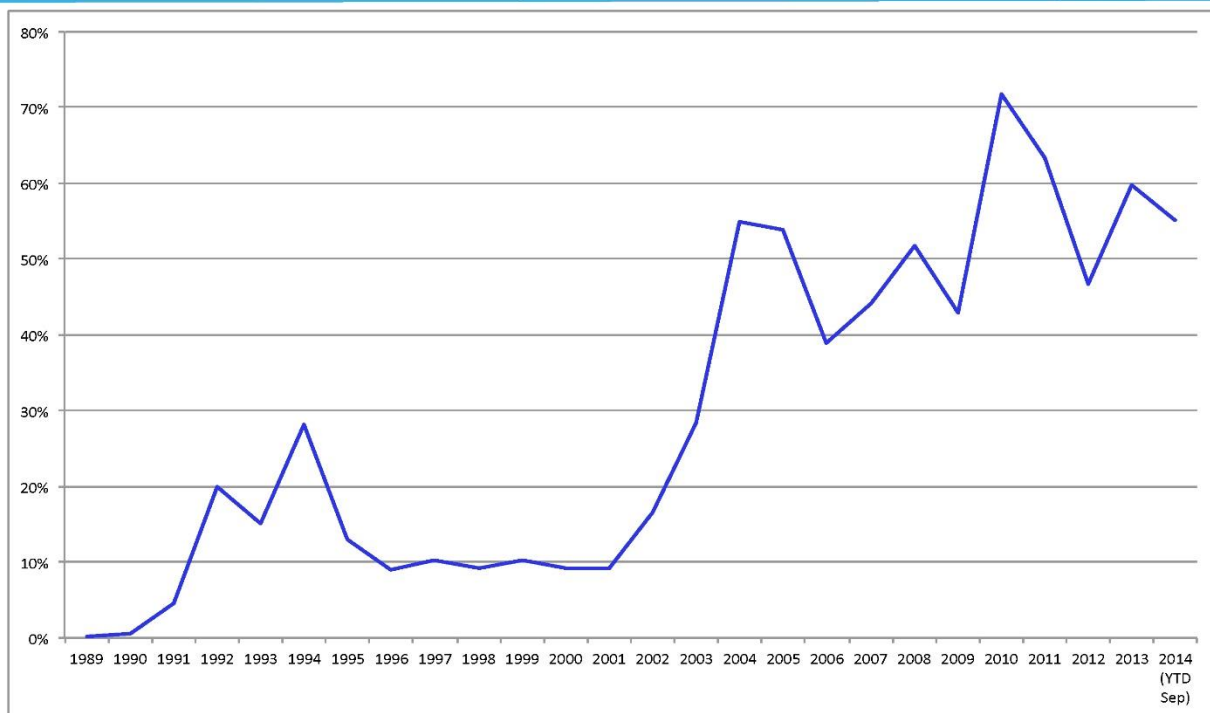


## The fiscal system needs urgent change

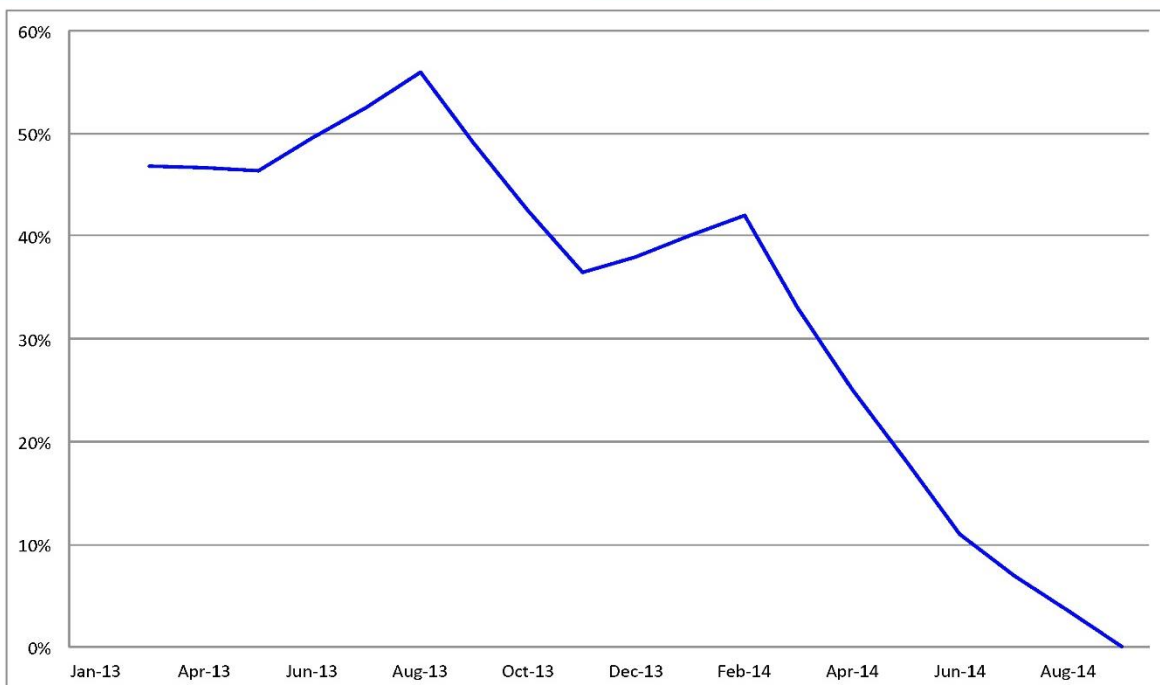




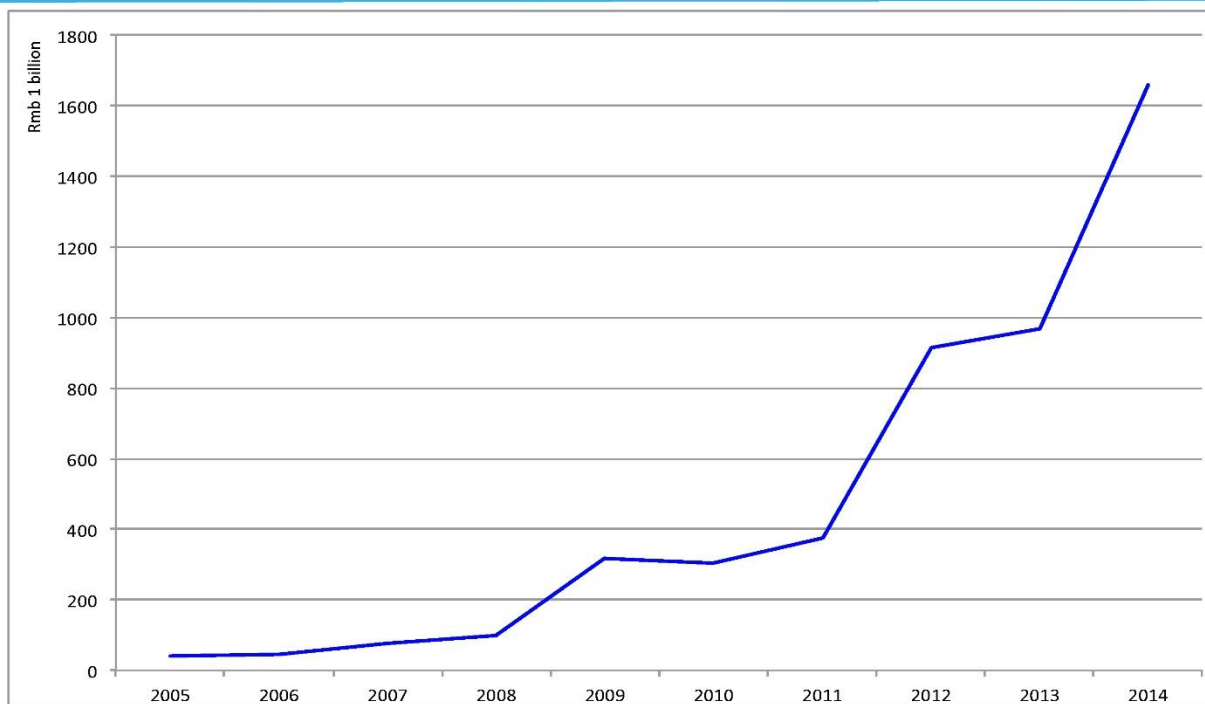
## The local governments would be bankrupt without land sales: Share of land sales of the fiscal budget



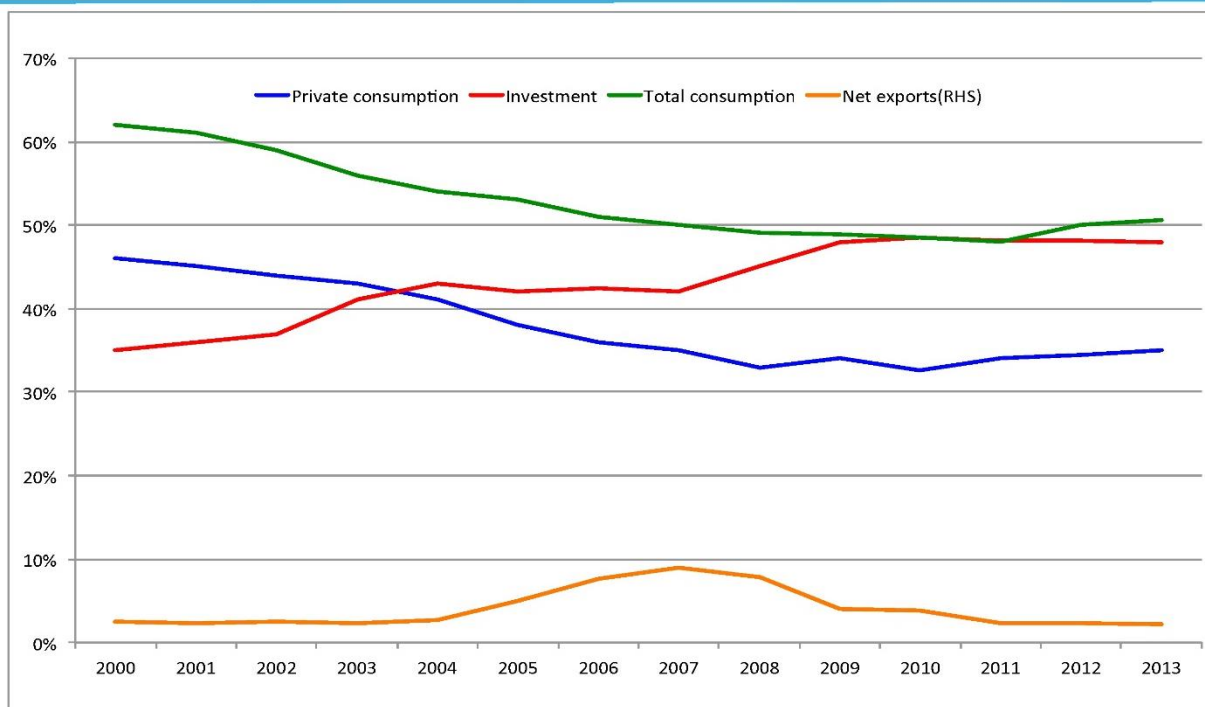
## Government land sales revenues hardly growing anymore



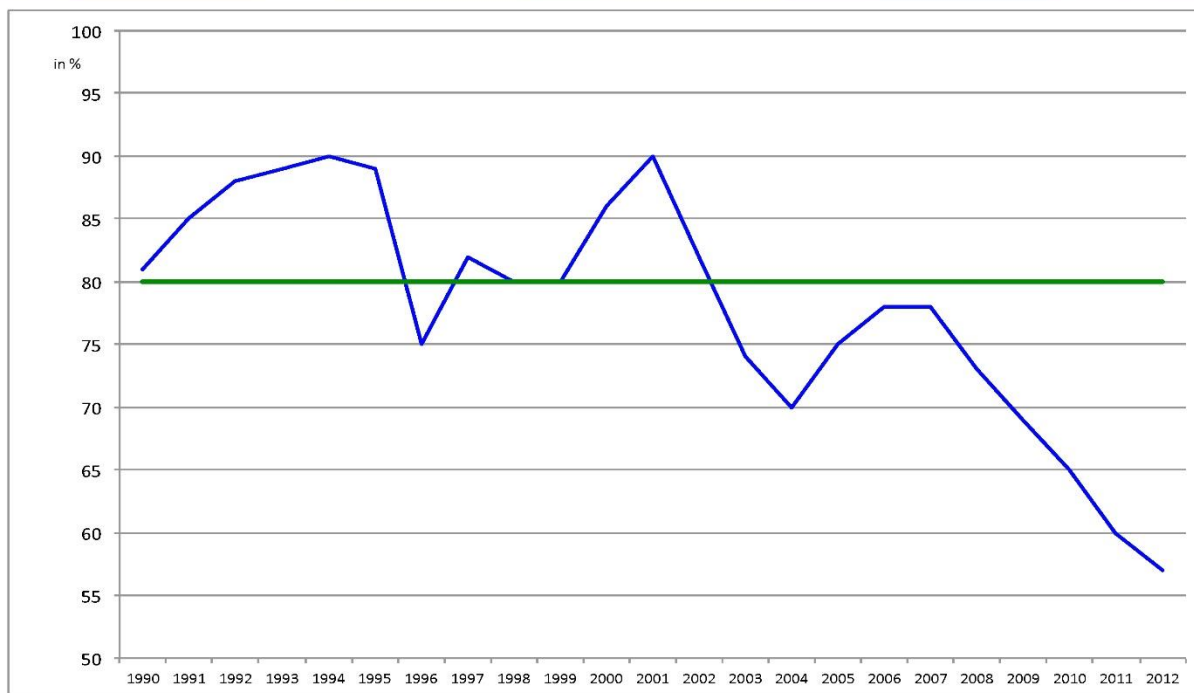
## The Local Government Finance Vehicles are out of control



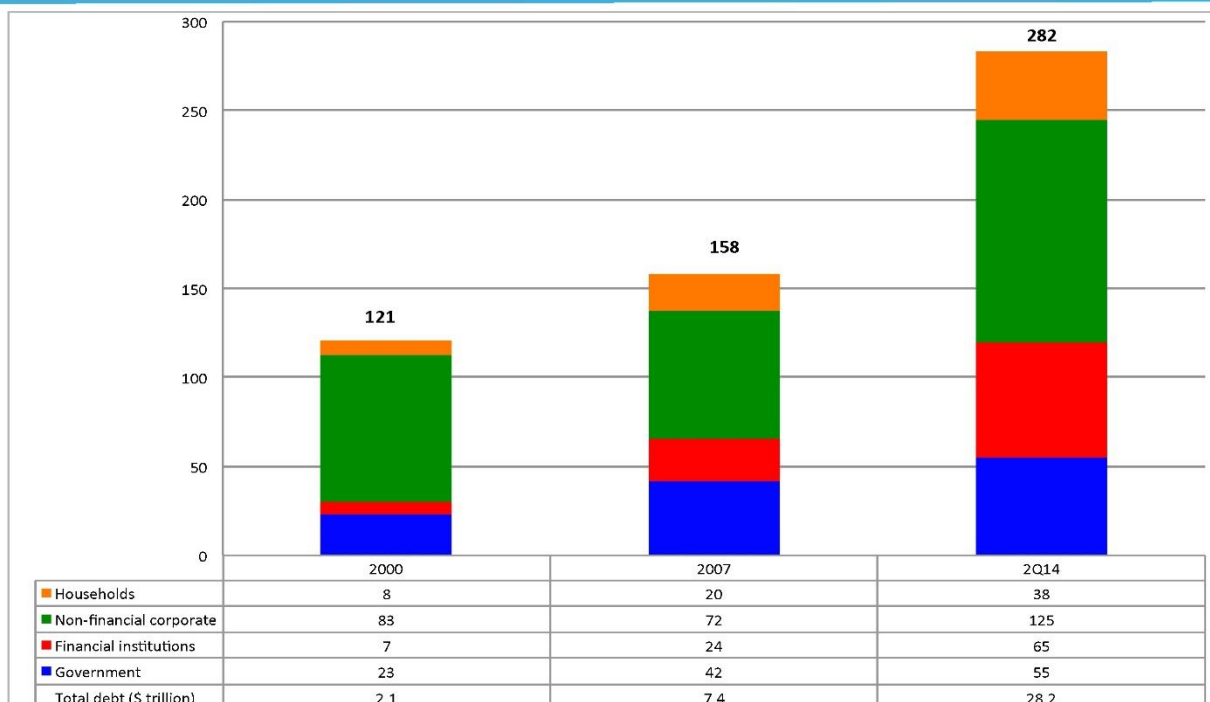
## GDP by expenditure components: Household consumption still extremely low



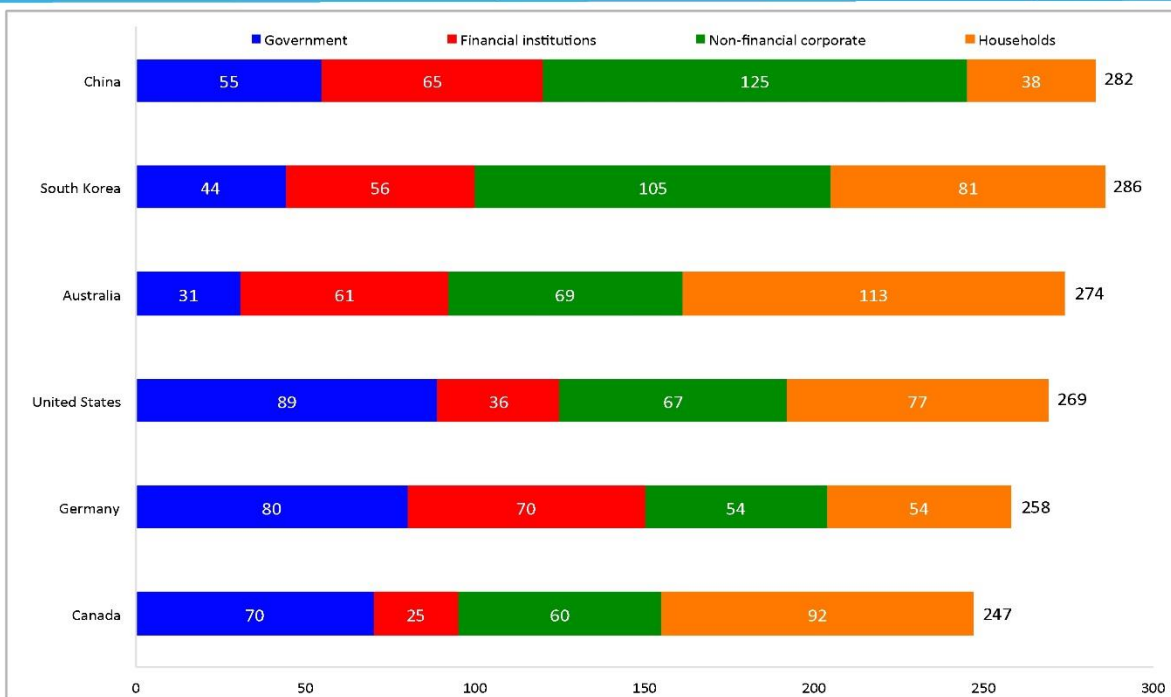
## Capacity utilization across all industries



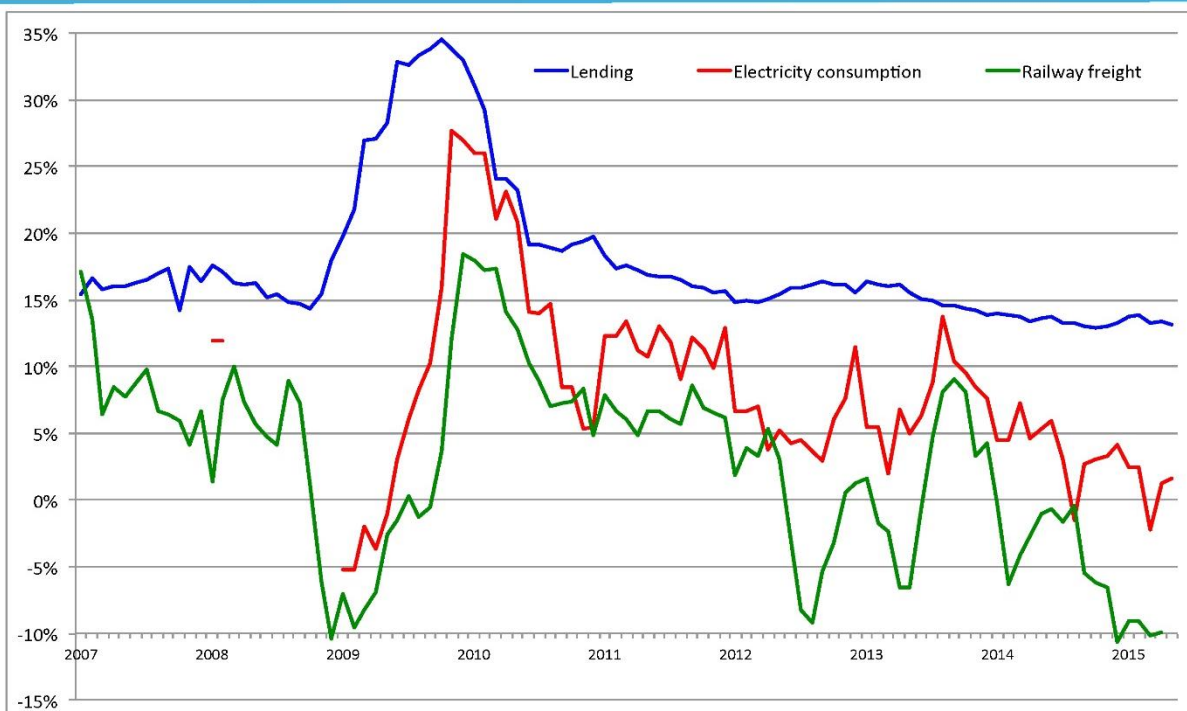
## Debt to GDP ratio growing fast



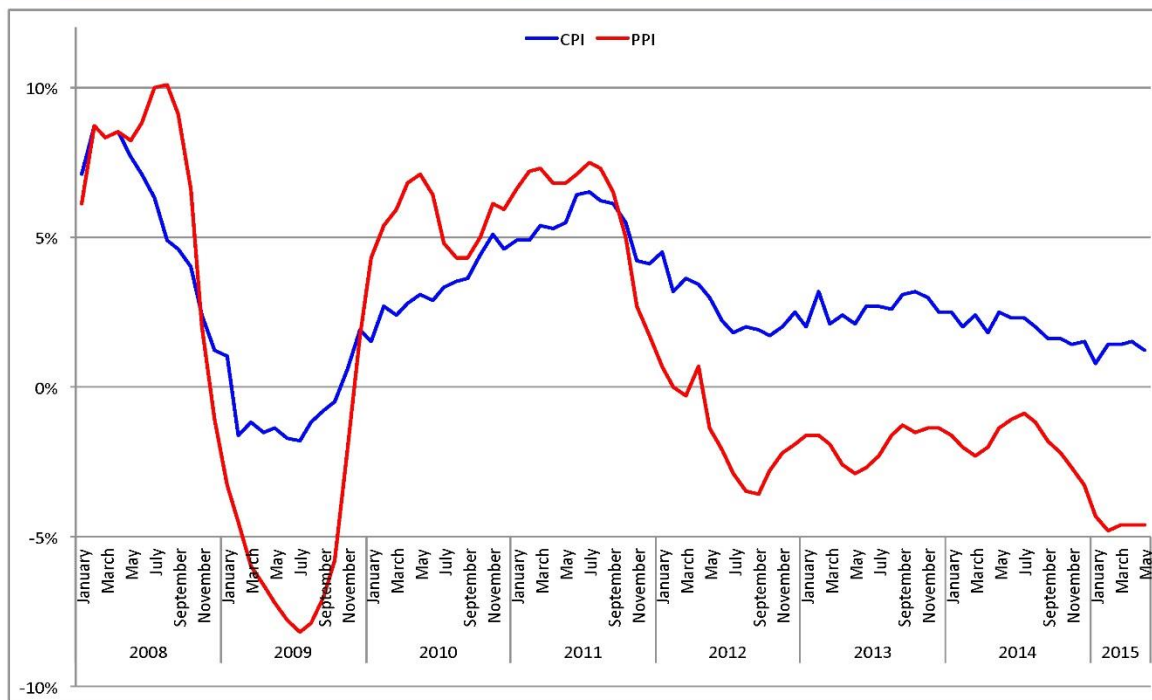
## Debt to GDP ratio very high by now



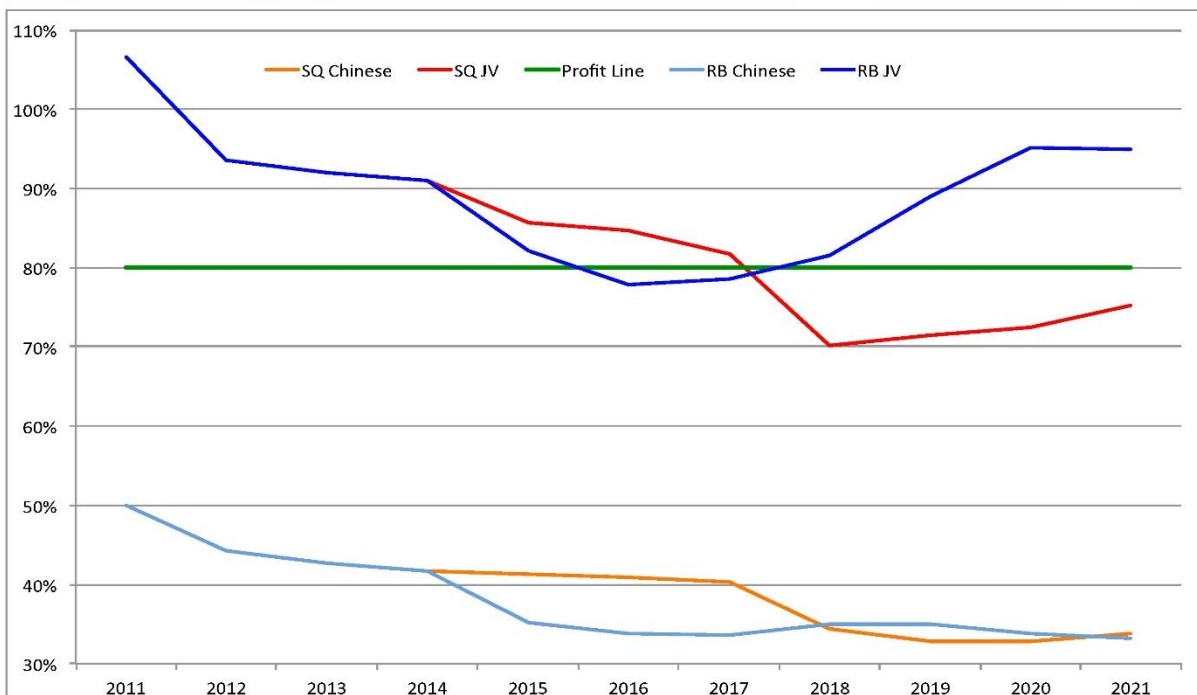
## Li Keqiang's Index: Industry is hardly growing!



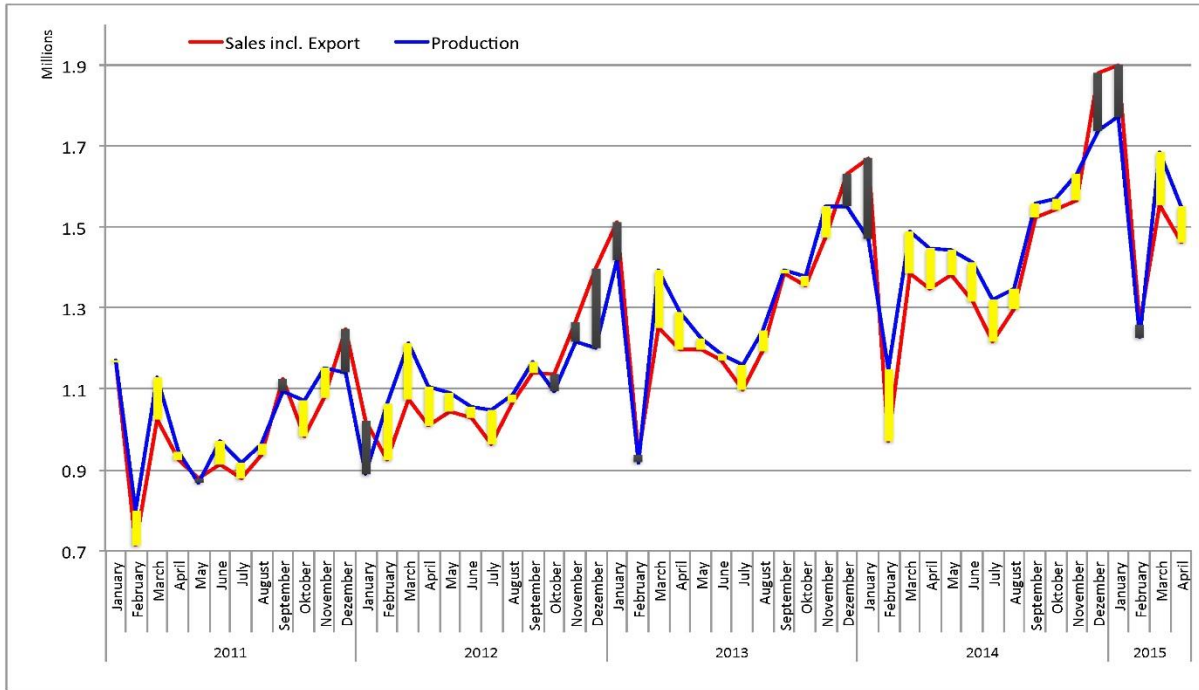
## CPI also going towards deflation now



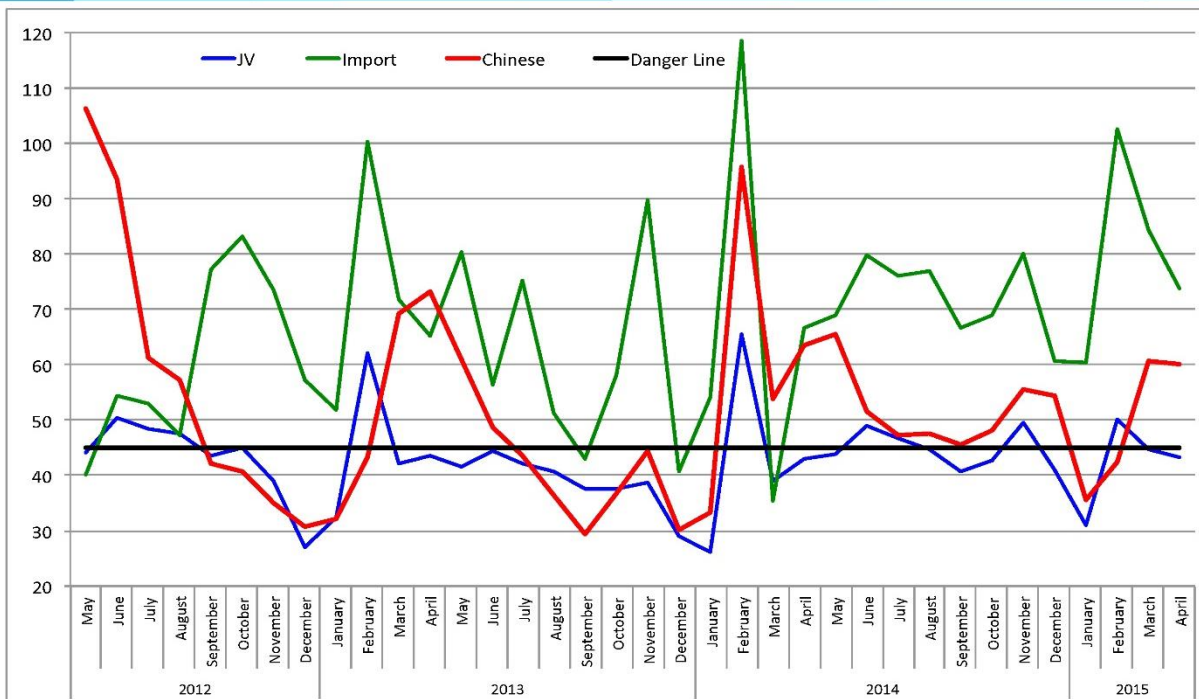
## Capacity utilization of the carmakers



## The carmakers have been building inventory



## The dealer inventories were in the red zone for several months



## The automakers keep up the production volumes for now

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- OEMs build own inventory
- Some have started reducing the production
- Dealers are pumped up and incentives are increasing
- List prices are decreased (Polo now at 76000 RMB)
- Financial penetration increased to 20% with players like BMW closer to 40% with the loans bundled into ABS
- Model ranges get more entry level models
- Models get lower specifications
- But: 70% of the dealers were unprofitable in 2014 and since late 2014 they push back

## The view on China is changing

---

- The new rules on the aftermarket, the dealerships and parallel imports are a major drag on the profitability for the OEMs
- The demand has decreased and led to hidden price reductions (discounts, financing, low spec models etc.)
- China is becoming a market with lower growth and decreasing margins
- Some OEMs, especially VW, have too much of their global business in China
- China will become a market to defend, not to grow anymore
- The competition will intensify and weaker players will be weeded out.
- The OEMs will look into new markets like ASEAN and Korea
- The perspective would only change mid term, if China gets beyond the Middle Income Trap





# StrikoWestofen Group

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**[www.strikowestofen.com](http://www.strikowestofen.com)**

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## **TITLE**

**Profits With Light Metal Castings Start In The Melt Shop**

## **ABSTRACT**

Faster than any of the other foundry centers worldwide, Chinese foundries took advantage on the aluminum melting technology provided by the StrikoWestofen Group. In just six years, StrikoMelter aluminum melting furnaces with a total yearly capacity of 1,100,000 tons molten metal have been taken into operation in China and neighbor countries – with a clear upwards trend. These foundries report that the highly efficient technology is not only turning into a crucial competitive factor but is also of great benefit to the environment. The savings made on natural gas and metal losses – compared to any other technology in the market – lead to significantly reduced unit costs for castings which provides these foundries a large competitive edge. Furthermore the reduction in CO2 and dust emissions is an important step towards a “green foundry” industry. The presentation features the specifics of the StrikoWestofen technology as well as concrete calculations what additional profits foundries gain when employing the technology.

# StrikoWestofen<sup>®</sup> Group



**Mr. Rainer Erdmann**  
**Managing Director Asia Operations**

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**CHN 215400 Taicang City**  
**Tel.: +86 512 53209802**  
**[www.strikowestofen.com.cn](http://www.strikowestofen.com.cn)**

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## **TITLE**

**Profits With Light Metal Castings Start In The Melt Shop**

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Faster than any of the other foundry centers worldwide, Chinese foundries took advantage on the aluminum melting technology provided by the StrikoWestofen Group. In just six years, StrikoMelter aluminum melting furnaces with a total yearly capacity of 1,100,000 tons molten metal have been taken into operation in China and neighbor countries – with a clear upwards trend. These foundries report that the highly efficient technology is not only turning into a crucial competitive factor but is also of great benefit to the environment. The savings made on natural gas and metal losses – compared to any other technology in the market – lead to significantly reduced unit costs for castings which provides these foundries a large competitive edge. Furthermore the reduction in CO2 and dust emissions is an important step towards a “green foundry” industry. The presentation features the specifics of the StrikoWestofen technology as well as concrete calculations what additional profits foundries gain when employing the technology.

**„The efficiency  
of a casting process  
starts in the melt shop.“**

*Quote from a leading die-caster  
and long-time StrikoWestofen customer*

**StrikoWestofen°**



- ① Operational costs of the melt shop**
- ② Reduction of energy consumption**
- ③ Increasing of metal yield & melting capacity**
- ④ Constant system uptimes**
- ⑤ Return on Investment**
- ⑥ StrikoWestofen your long term partner**

**StrikoWestofen°**

## Energy costs and loss of metal drive operational costs

StrikoWestofen<sup>o</sup>

- › Over 95% of the total cost of furnace ownership is generated by
  - › Energy consumption
  - › Loss of metal

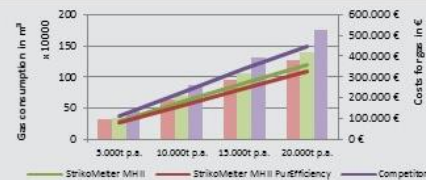
- › More than 50% of the energy used for an aluminum die-casting operation goes into
  - › Melting process
  - › Holding process



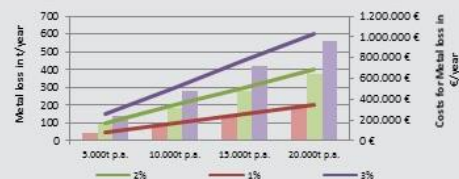
## STRIKOMELTER<sup>®</sup> : wins the cost battle

StrikoWestofen<sup>o</sup>

- › Energy consumption



- › Metal yield



- › System availability



Uptimes up to 99%



StrikoWestofen<sup>o</sup>

**Melt shop costs down**

**STRIKOMELTER<sup>®</sup>: Tower Melter**

Efficiency. Powered by knowledge.

Page 5

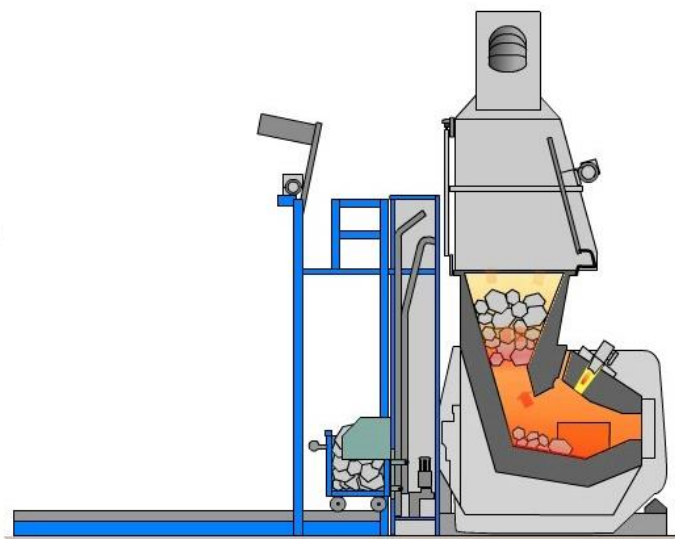
**ETAMAX<sup>®</sup> shaft geometry:  
optimizes melting process**

StrikoWestofen<sup>o</sup>

- › ETAMAX<sup>®</sup> shaft geometry uses hot exhaust gases from holding and melting to preheat the charging material

**Results:**

- › Rapid melting process
- › High melt quality
  - › Minimal oxide inclusions
  - › Density index 6% or better
- › Low energy consumption
- › Reduced CO<sub>2</sub>-emissions



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Page 6

**Facts and figures:**  
**on energy consumption**  
STRIKOMELTER® shaft melting furnace

StrikoWestofen®

- › Energy consumption of only 52 m<sup>3</sup> gas/t (validated under operating conditions)



- › Savings of 10 to 50 percent compared to other common technologies



**STRIKOMELTER® :**  
**easy on CO<sub>2</sub> emissions**

StrikoWestofen®

- › CO<sub>2</sub> emissions of 129 kg/t
  - › Compared to 180 kg/ton with other tower melter

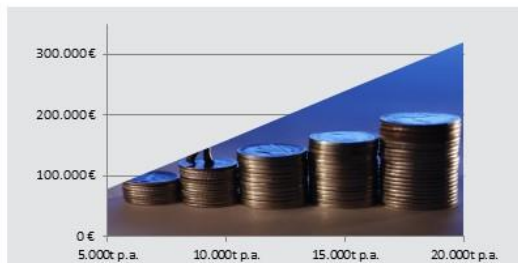
- › CO<sub>2</sub> savings / year
  - › Emissions of 400 – 900 cars



## STRIKOMELTER® technology: increases metal yield & productivity

StrikoWestofen®

- › Metal yield up to 99,7 %
  - › 1% metal loss = Extra costs of €100,000 / year



- › High productivity
  - › Charging ingots and production returns



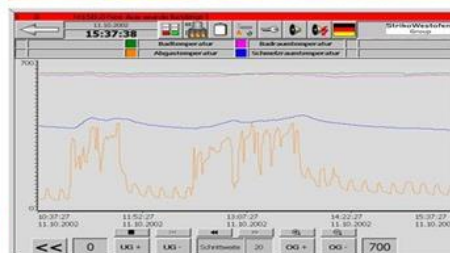
## STRIKOMELTER®: assures process reliability

StrikoWestofen®

- › System uptimes up to 99 %



- › Constant metal temp ± 5° Celsius



## STRIKOMELTER®: allows for flexibility

StrikoWestofen®

### › Automated charging system

Charging System

Conveyers System



### › Melting capacity

- › 350 kg/hour - 7,000 kg/hour



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Page 11

## Process reliability: through extended furnace life time

StrikoWestofen®

### › Long furnace lifetime

- › More than 20 years
- › With appropriate maintenance



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## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*		
Energy consumption p.a.		
Energy costs p.a.		
Metal losses p.a.		
Costs for metal losses p.a.		
Total costs p.a.		
<b>Saving potential p.a.</b>		
<b>Return on investment</b>		

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
<b>Melting rate*</b>	<b>9.000 t</b>	<b>9.000 t</b>
Energy consumption p.a.		
Energy costs p.a.		
Metal losses p.a.		
Costs for metal losses p.a.		
Total costs p.a.		
<b>Saving potential p.a.</b>		
<b>Return on investment</b>		

\*Based on:

Melting rate 1,5 t per hour  
6.000 hr/y = 3 shifts a day (each 8 hr), 250 working days a year

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.		
Metal losses p.a.		
Costs for metal losses p.a.		
Total costs p.a.		
Saving potential p.a.		
Return on investment		

### \*Energy consumption/Energy costs

Melting: 540 kWh/t	Melting: 750 kWh/t
Holding: 45 kWh/h	Holding: 45 kWh/h
0,35 €/m³ natural gas	0,35 €/m³ natural gas

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## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
Metal losses p.a.		
Costs for metal losses p.a.		
Total costs p.a.		
Saving potential p.a.		
Return on investment		

### \*Energy consumption/Energy costs

Melting: 540 kWh/t	Melting: 750 kWh/t
Holding: 45 kWh/h	Holding: 45 kWh/h
0,35 €/m³ natural gas	0,35 €/m³ natural gas

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## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
<b>Metal losses p.a.</b>	<b>90 t</b>	<b>180 t</b>
Costs for metal losses p.a.		
Total costs p.a.		
Saving potential p.a.		
Return on investment		

<b>*Metal loss</b>	
Melting rate: 9.000 t p.a. Metal loss: < 1 %	Melting rate: 9.000 t p.a. Metal loss: ~ 2 %

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
Metal losses p.a.	90 t	180 t
<b>Costs for metal losses p.a.</b>	<b>153.000 €</b>	<b>306.000 €</b>
Total costs p.a.		
Saving potential p.a.		
Return on investment		

<b>*Metal loss</b>	
Melting rate: 9.000 t p.a. Metal loss: < 1 % 1.700 €/t Al	Melting rate: 9.000 t p.a. Metal loss: ~ 2 % 1.700 €/t Al

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
Metal losses p.a.	90 t	180 t
Costs for metal losses p.a.	153.000 €	260.100 €
<b>Total costs p.a.</b>	<b>327.447 €</b>	<b>520.347 €</b>
Saving potential p.a.		
Return on investment		

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
Metal losses p.a.	90 t	135 t
Costs for metal losses p.a.	153.000 €	260.100 €
Total costs p.a.	327.447 €	474.447 €
<b>Saving potential p.a.</b>	<b>192.900 €</b>	
Return on investment		

## STRIKOMELTER®: Return on Investment

StrikoWestofen®

	STRIKOMELTER® PUREFFICIENCY®	Competitor -shaft melting furnace-
Melting rate*	9.000 t	9.000 t
Energy consumption p.a.	498.420 m³	612.420 m³
Energy costs p.a.	174.447 €	214.347 €
Metal losses p.a.	90 t	135 t
Costs for metal losses p.a.	153.000 €	260.100 €
Total costs p.a.	327.447 €	474.447 €
<b>Saving potential p.a.</b>	<b>147.000 €</b>	
<b>Return on investment</b>	<b>&lt; 2 years</b>	



StrikoWestofen®

**StrikoWestofen your long-term partner**

**StrikoMelter®: Shaft melting furnace**

## StrikoWestofen

## StrikoWestofen<sup>o</sup>

### We are where are customers are

- › Subsidiaries, sales and service partners
  - › In 25 countries
  - › Throughout Europe, Asia and America



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## StrikoWestofen

## StrikoWestofen<sup>o</sup>

### With an impressive track record

- › Customer base
  - › leading manufacturers
  - › leading foundries
  - › around the globe

- › Renault Deutschland AG
- › Daimler AG
- › Siemens AG
- › ZF Friedrichshafen AG
- › Çelikel

- › Partnerships over decades
  - › 14% > 20 years
  - › 58% 5 – 19 years
  - › 18% 1 - 4 years



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Start producing **more parts** with  
**better quality at lower cost**  
with StrikoWestofen today

**PUREFFICIENCY®. FOR YOU AND FOR NATURE.**

StrikoWestofen <sup>o</sup> | +49 2261 7091 0 | [sales@strikowestofen.com](mailto:sales@strikowestofen.com)

# GEELY



**Prof. Fei Xiong**  
**Chief Engineer & Director of**  
**Auto Lightweight Department**

**Geely Automobile Research Institute**  
**CHN 311228 Hangzhou - Xiaoshan District /**  
**Zhejiang**  
**Tel.:+86 571 58109321**  
**[www.geely.com](http://www.geely.com)**

## **TITLE**

**Automotive Lightweight Promoting The Application Of Aluminium**

## **ABSTRACT**

With the environmental and government requirement, reducing weights for auto vehicle are becoming one of the hottest topics globally. Automotive lightweight technology is pushing the fast development of new material, new manufacturing process and the structure optimization. High strength material, light materials such as Al, Mg etc. are used widely in auto body to skin off some of the weight added on due to the factors of the safety, comfort and others. This presentation will be focusing on the following topic: (1) Full Aluminium Body in Geely's New energy sources vehicle (PEV); (2) Setting up the PEV lightweight target and lightweight technology to be used; (3) Typical Al application in details; (4) Aluminium body structure application's feasibility analysis including manufacturing cost evaluation; and (5) challenges facing the application of aluminium body. A couple of examples of Al alloy components' development are to be presented.



## Full Aluminium Body for PEV

Fei Xiong (Ph.D)

GEELY Auto



Produce\_0.avi

**Why aluminum – Lightweight Technology**

**Geely PEV Project**

**PEV Lightweight Target**

**PEV Lightweight Technology Analysis**

**Challenges**

**Why aluminum – Lightweight Technology**

**Geely PEV Project**

**PEV Lightweight Target**

**PEV Lightweight Technology Analysis**

**Challenges**

## GEELY Why Aluminium - Lightweight?

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## GEELY Why Aluminium - Lightweight?

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**GEELY**

## Why Aluminium - Lightweight?



~35 kg



~ 13 kg

**GEELY**

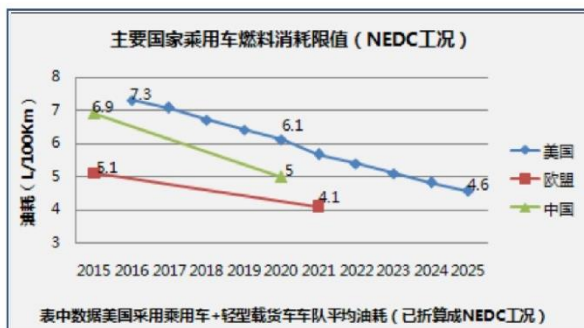
## Why Aluminium - Lightweight?

--- Automotive Lightweight Technology Background

### Policies

#### Fuel

GB19578、CAFE、ACEA



#### Emission

July 1, 2014 – National IV emission standard

### Customers

**Fuel Economy**

**Vehicle Dynamics**

### OEM Competitiveness

#### Cost

1kg reduction in weight results in \$10 saving.

#### Competitiveness

Lightweight technology – company core competitiveness

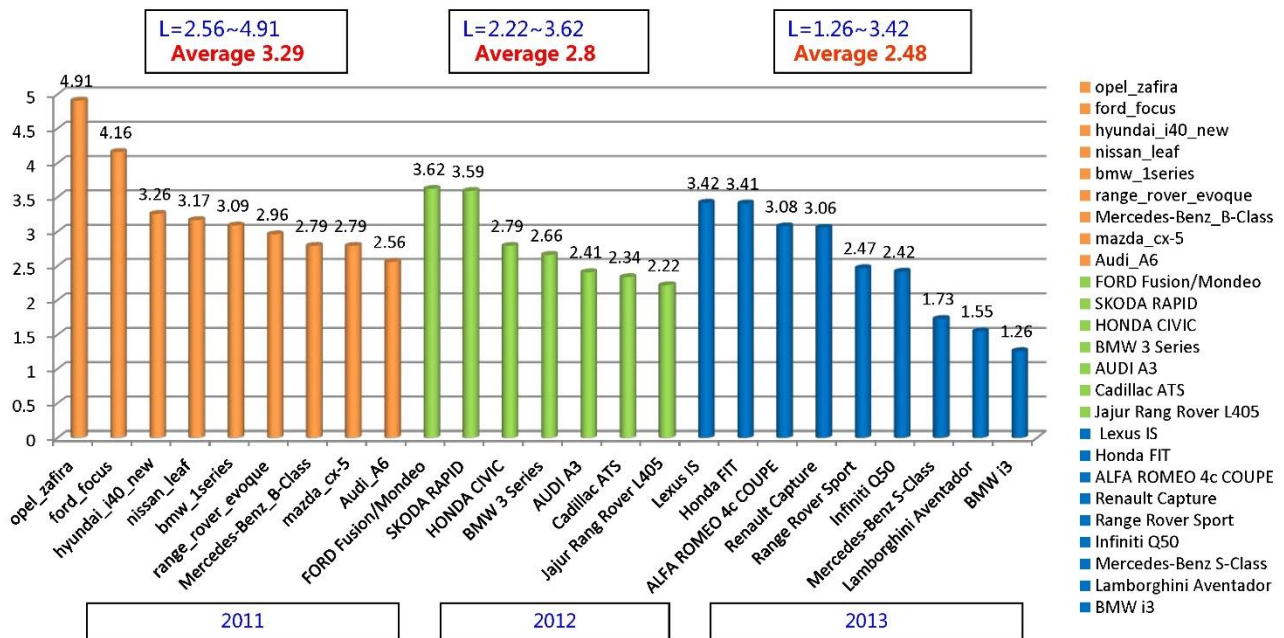
Toyota: Target – weight reduction of 10~30% by 2016 in its all small to medium vehicles

.. Almost every OEM has its own lightweight target . . .

## GEELY Why Aluminium - Lightweight?

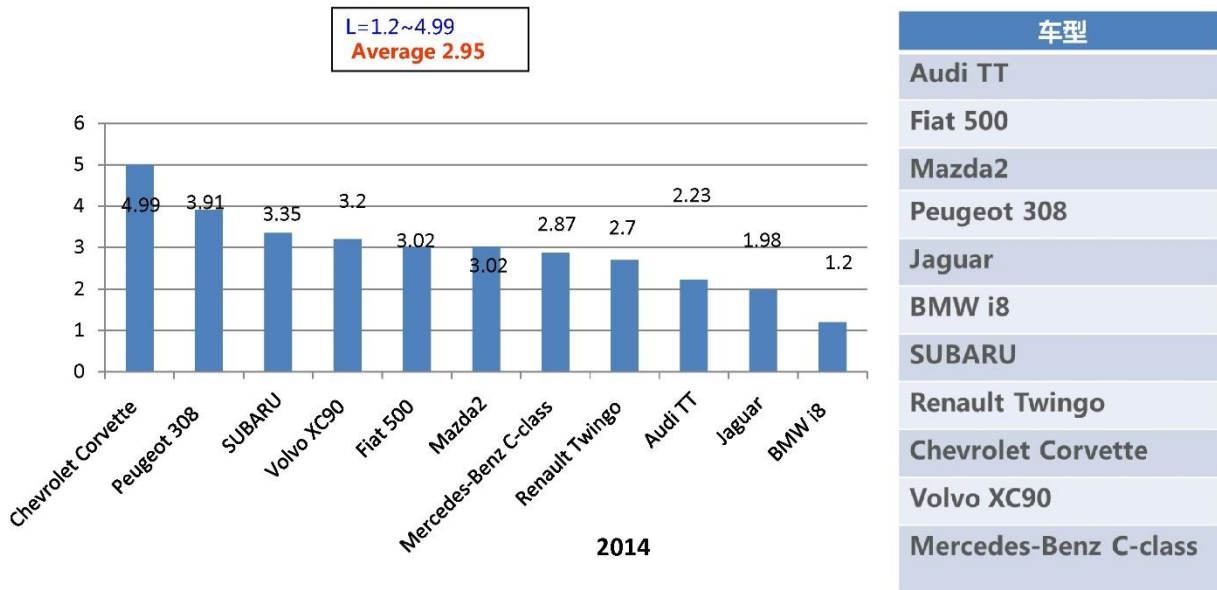
### --- Automotive Lightweight Technology Background

Lightweight Index Trend



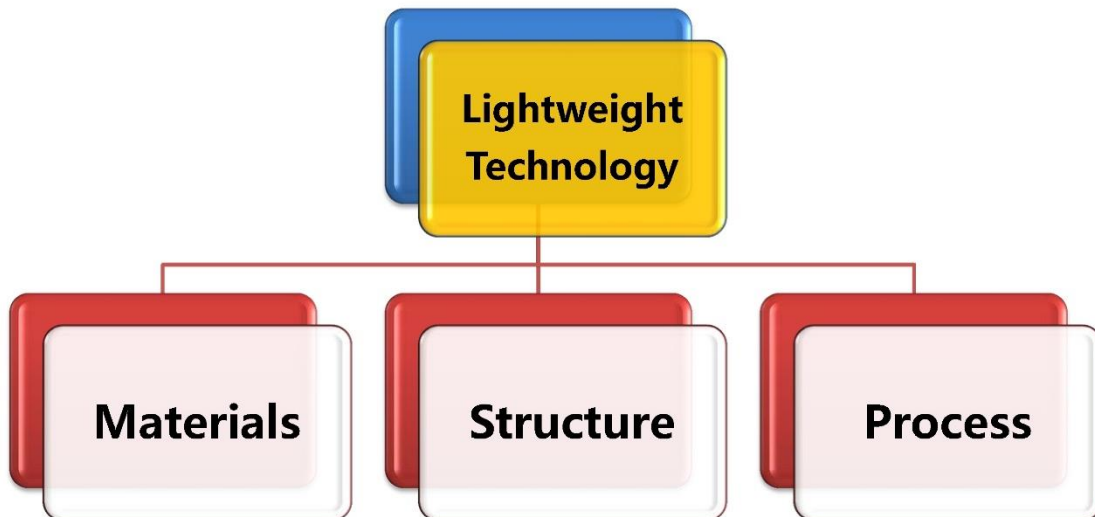
## GEELY Why Aluminium - Lightweight?

### --- Automotive Lightweight Technology Background



## GEELY Why Aluminium - Lightweight?

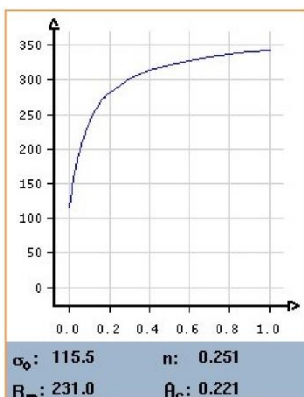
--- Automotive Lightweight Technology Background



## GEELY Why Aluminium - Lightweight?

--- Automotive Lightweight Technology Background

➤ One of the best candidate materials for lightweight



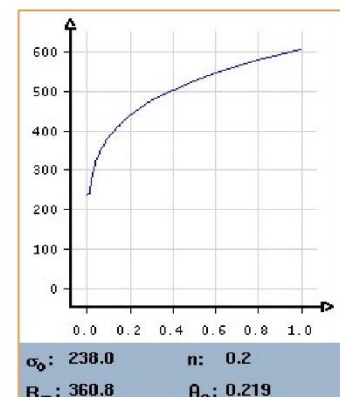
6016T6, 1.0mm

材料轻量化指数计算  
以弯曲情形为例  
( $L^2/h = 1000$ )

6016T6	B180H1
1510	768

$$LBK = \frac{R_{\sigma 0.2}}{(\rho \cdot g) \cdot L^2/h}$$

LBK越大，所选择的材料就越适合轻量化设计针对的载荷情况



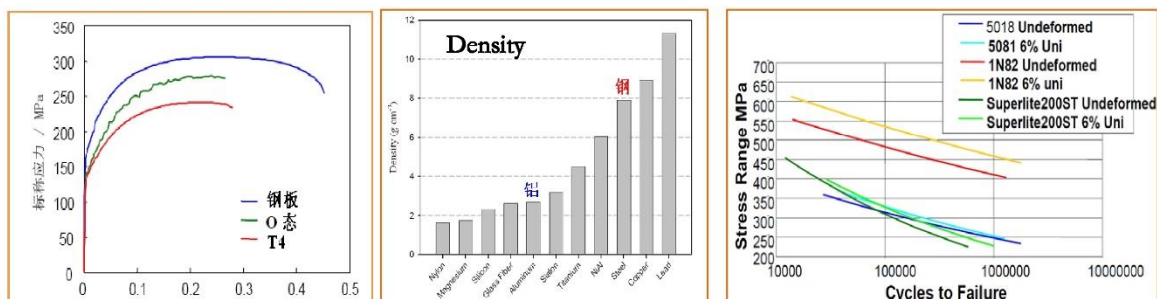
B180, 0.7mm

**LBK - Material Lightweight Index**

Al - better lightweight material in comparison with steel.  
(Higher load capacity per unit weight)

## GEELY Why Aluminium - Lightweight?

### --- Automotive Lightweight Technology Background



板厚 (mm)	抗拉强度 (MPa)	屈服强度 (MPa)	延伸率 (%)	拉伸应变硬化指数 n 值 (10-15%)	塑性应变比 r 值 (15%)
0.9	241	133	28	0.26	0.84
1.0	280	142	28	0.30	0.78
0.7	309	170	44	0.23	1.59

←钢板

Automotive Lightweight demand is pushing wider application of Al alloys.

$$S\sigma_n \geq S_o\sigma_o \quad \Rightarrow \quad \sigma_n \geq T_o\sigma_o / T_n$$

## GEELY Contents

Why aluminum – Lightweight Technology

Geely PEV Project

PEV Lightweight Target

PEV Lightweight Technology Analysis

Challenges

## GEELY Full Aluminium in Geely PEV

AMA platform

XXX model – 5 yrs 200K



Model*	Length mm	Width mm	Height mm	W/Base mm	Distance km	Max Speed km/h
A	2742	1566	1566	1868	250	120

## GEELY Contents

Why aluminum – Lightweight Technology

Geely PEV Project

**PEV Lightweight Target**

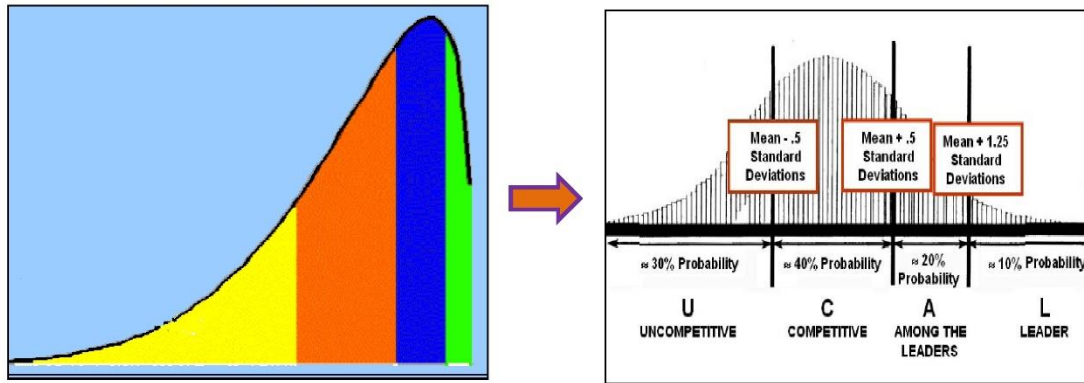
PEV Lightweight Technology Analysis

Challenges



## GEELY PEV Lightweight Target (PALS Model)

### - Products Attribute Leadership Strategy



Based on the benchmark and competitors 'data ( no less than 5 data) , calculating the average to define C' s average.

L - ~10% ; A - ~20% ; C - ~40% ; U - ~30% ;

每个子组的标准差:

$$S = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$$

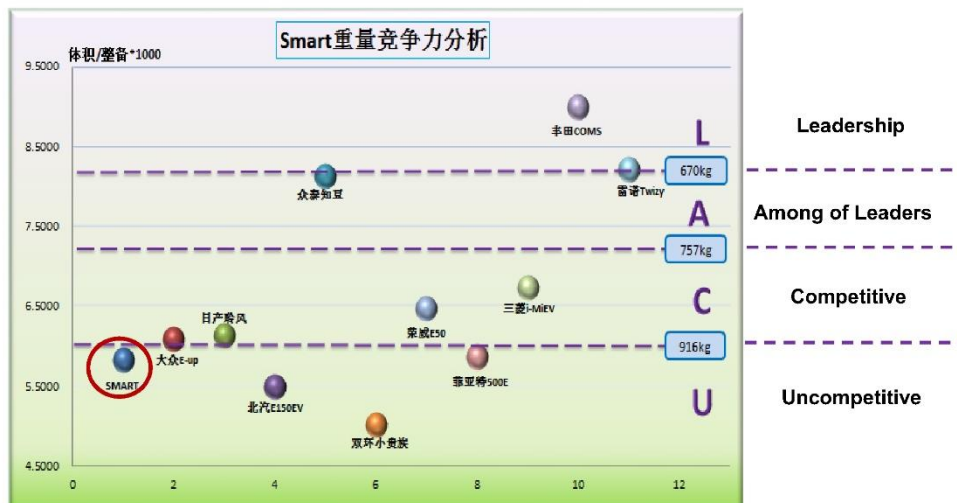
第 17 页

## GEELY PEV Lightweight Target (PALS Model)

### - Products Attribute Leadership Strategy

#### Benchmark - Smart

Smart curb mass: 943kg , PALS model shows it's in the uncompetitive range.



A lightweight target of 750kg is set with 5 different body structure designs

## GEELY PEV Lightweight Target (PALS Model)

- Products Attribute Leadership Strategy

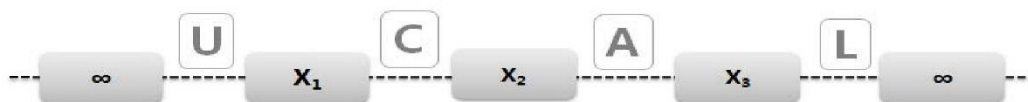
Sedan 轻量化重量设计模型

标杆车信息		竞品车信息		开发车型信息	
迈腾		BMW 3系		吉利帝豪	
长(mm)	4865	长(mm)	4624	长(mm)	4956
宽(mm)	1820	宽(mm)	1811	宽(mm)	1860
高(mm)	1475	高(mm)	1454	高(mm)	1516
轴距(mm)	2812	轴距(mm)	2810	轴距(mm)	2850
整备质量(kg)	1545	整备质量(kg)	1470	整备质量*(kg)	1500
				整备质量**(kg)	1450

$$f(\rho) = \frac{M}{(k*(L-wh)+wh)*W*H}$$

\* 针对标杆车整备质量

\*\* 针对竞品车整备质量



## GEELY Contents

Why aluminum – Lightweight Technology

Geely PEV Project

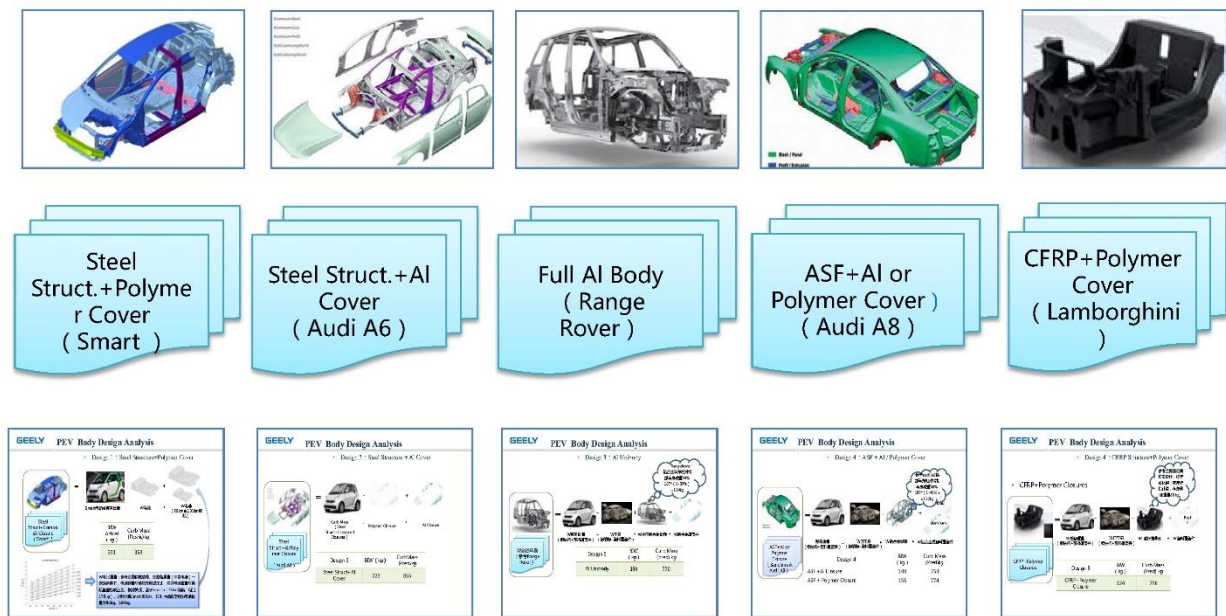
PEV Lightweight Target

**PEV Lightweight Technology Analysis**

Challenges

## GEELY PEV Lightweight Technology

### PEV Body Design Analysis



## GEELY PEV Lightweight Technology

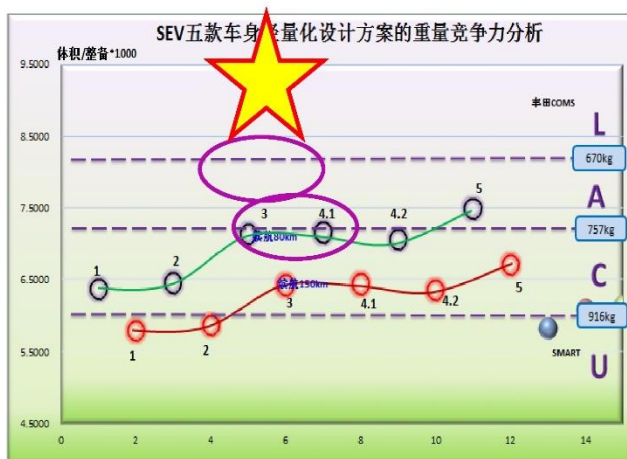
### SEV Body Design Analysis

- Lightweight Design – Mass Analysis

#### BIW & Curb Mass Evaluation

No.	Body Design Method	Predic. BIW (kg)	Pred. Curb Mass (kg)
1	Steel Struct.+Polymer Cover	231	863
2	Steel Struct.+Al Cover	223	855
3	Full Al Body	150	770
4	ASF+Al Cover	148	768
	ASF +Polymer Cover	156	774
5	CFRP+Polymer Cover	124	741

### PAS Analysis



Based on the PALS analysis:

- ① Design 1 and 2 shown uncompetitiveness (Range U)
- ② Design 3, 4 and 5 shown the curb mass is among A or C.
- ③ Design 5 shown the curb mass is minimum, among leaders.

### Lightweight Recommendation

Annual Production > 10000



Full Al Body

Project	Item	Material	Weight (kg)	Volume (mm³)	Cost (USD)	Weight (kg)	Volume (mm³)	Cost (USD)
Full Al Body	Body	Aluminum	1500	150000000	150000	1500	150000000	150000
	Chassis	Aluminum	1000	100000000	100000	1000	100000000	100000
	Engine	Aluminum	500	50000000	50000	500	50000000	50000
	Transmission	Aluminum	300	30000000	30000	300	30000000	30000

Annual Production < 5000台



ASF+Al/Polymer

Body	Weight (kg)	Volume (mm³)	Material	Weight (kg)	Volume (mm³)	Cost (USD)
Design 1	1500	150000000	Aluminum	1500	150000000	150000
Design 2	1200	120000000	Aluminum	1200	120000000	120000
Design 3	1000	100000000	Aluminum	1000	100000000	100000
Design 4	800	80000000	Aluminum	800	80000000	80000
Design 5	670	67000000	Aluminum	670	67000000	67000

CFRP Design



CFRP+Polymer (Lamborghini)

Design	Weight (kg)	Volume (mm³)	Material	Weight (kg)	Volume (mm³)	Cost (USD)
Design 1	1500	150000000	Aluminum	1500	150000000	150000
Design 2	1200	120000000	Aluminum	1200	120000000	120000
Design 3	1000	100000000	Aluminum	1000	100000000	100000
Design 4	800	80000000	Aluminum	800	80000000	80000
Design 5	670	67000000	Aluminum	670	67000000	67000

Why aluminum – Lightweight Technology

Geely PEV Project

PEV Lightweight Target

PEV Lightweight Technology Analysis

**Challenges**

### Lightweight Design and Manufacturing Process

- Example 1: Aluminium Engine Hood

GEELY Al Engine Hood Cost Evaluation						
Cost Comparison between Al and Steel Engine Hoods						
	Al Engine Hood		OneTime Investment	Per Unit Cost	Steel Engine Hood	
					OneTime Investment	Per Unit Cost
<b>Mat.Cost</b>	Int. Panel			¥190.00		¥87.00
	Ext. Panel			¥210.00		¥96.00
<b>Stamp Cost</b>	Tooling (RMB\$10K)		¥350.00	¥17.50	Tooling (RMB\$10K)	¥350.00
	Stamping(RMB\$)			¥0.80	Stamping(RMB\$)	¥0.80
<b>Joining</b>	Adhesive (RMB\$)			¥5.00	Adhesive (RMB\$)	¥5.00
	SPR (RMB\$)		¥20.00	¥1.00	Spot Welding (RMB\$)	¥3.00
	SPR Cost (RMB\$)			¥15.00		
<b>Coating</b>	Filter Equip.		¥2.00	¥0.10	No Change	
	F.			¥1.00		
	<b>Total (RMB)</b>			<b>¥440.40</b>	<b>Total (RMB)</b>	
					<b>¥209.30</b>	

## GEELY Challenge

### Lightweight Design and Manufacturing Process

- Example 2: Aluminium Front Bumper

**GEELY**

#### Front Bumper Impact Result Comparison

Front Impact Results

	Longitudinal Beam Collapse (mm)	LB Energy Absorption (%)	L/R B Pillar Lower End Acceleration(g)	L/R Door Frame Deformation (mm)
Orig.(Steel)	425.8	36.60	34.20/34.70	0.817/2.732
Proposal 1	558.1	30.56	37.61/40.58	1.450/3.333
Proposal 2	455.5	36.89	36.93/40.28	1.255/3.126
Proposal 3	471.2	37.19	35.07/42.28	0.811/2.981

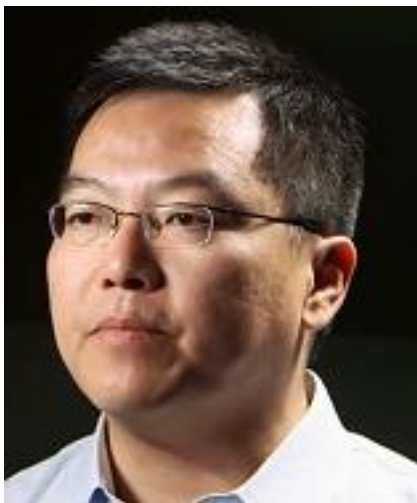
40% Offset Impact Results

	Longitudinal Beam Collapse (mm)	LB Energy Absorption (%)	L/R B Pillar Lower End Acceleration(g)	L/R Door Frame Deformation (mm)
Orig.(Steel)	619.5	15.20	35.16/40.49	35.620/10.310
Proposal 1	641.1	12.84	41.35/43.58	56.484/12.337
Proposal 2	634.0	15.45	46.3/40.54	41.597/13.844
Proposal 3	658.6	16.02	42.05/41.94	40.410/6.900

## GEELY Challenge







**Mr. James Liu**  
**Managing Director & Vice President of**  
**Asia Auto**

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**Tel.: +86 21 60355121**  
**[www.novelis.com](http://www.novelis.com)**

## **TITLE**

**Novelis Aluminum BIW Solution**

## **ABSTRACT**

Topic:

- High Volume Aluminum Solutions for Lightweighting
- Solutions for Forming & High Speed Joining
- Tailored Solutions for Material Utilization
- Alloys for Strength and Crash Energy
- Closed Loop Recycling
- Adhesive Bonding Technology Innovation



## High Volume Aluminum Solutions for Lightweighting

James Liu  
Vice President – Automotive, Novelis Asia  
Managing Director, Novelis China  
July, 2015



## Novelis is the Global Industry Leader in Aluminum Sheet



● Existing Plant    ● Existing Plant: Brownfield Expansion    ● New Plant: Greenfield Expansion

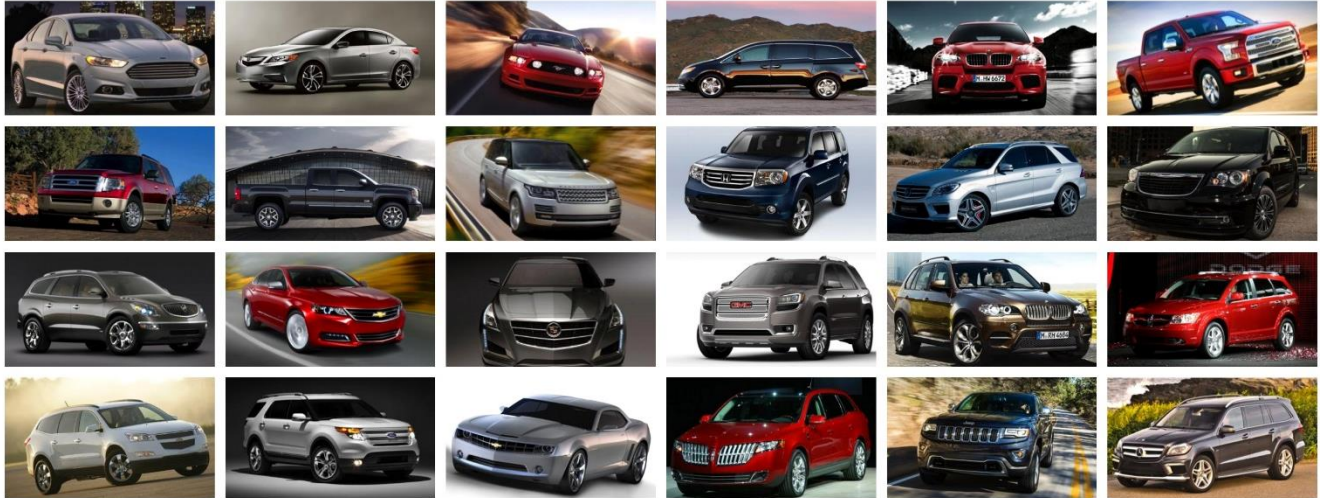
GLOBAL ALUMINUM LEADER IN:

Flat Rolled Products

Automotive BiW Sheet

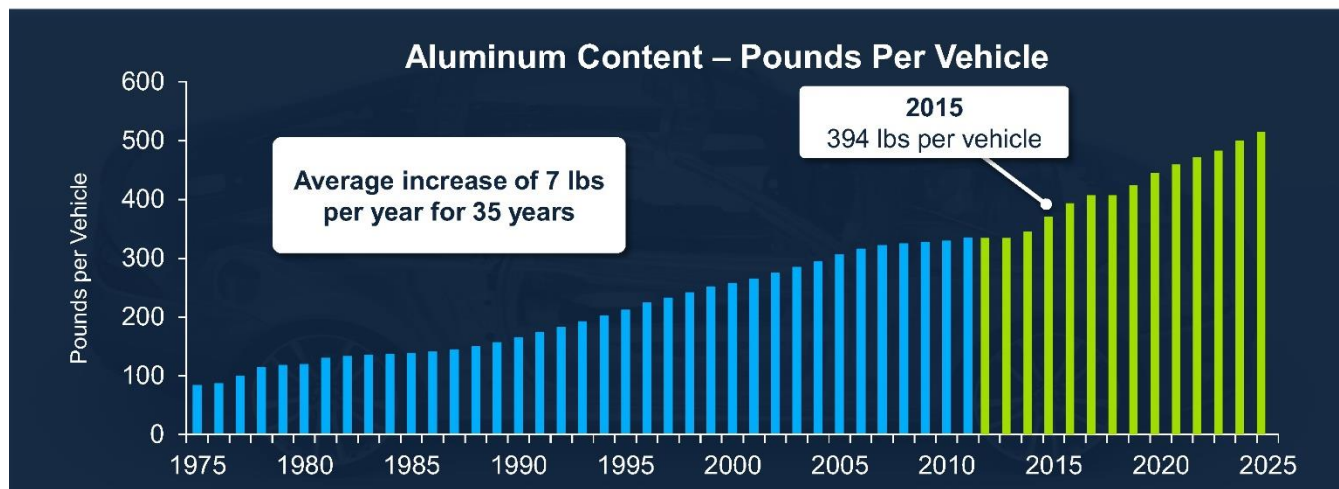
Recycling

## Where Do You Find Novelis Aluminum Today?



Not just aluminum, Novelis Aluminum.

## 40 Years of Uninterrupted Growth



Source: Ducker Worldwide 2014

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## Key Factors for Mass and Cost Efficiency

- High Form and High Strength Alloys for Part Count and Thickness Reduction
- Optimize Material Utilization
- Establish a Closed-Loop System with High Recycled Content Products
- High Speed Continuous Joining
- Standardize "Fit for Service" Specs
- SAFETY DURABILITY DESIGN
- MANUFACTURING
- SUSTAINABILITY

5

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## Attention to These Key Factors Pays Off



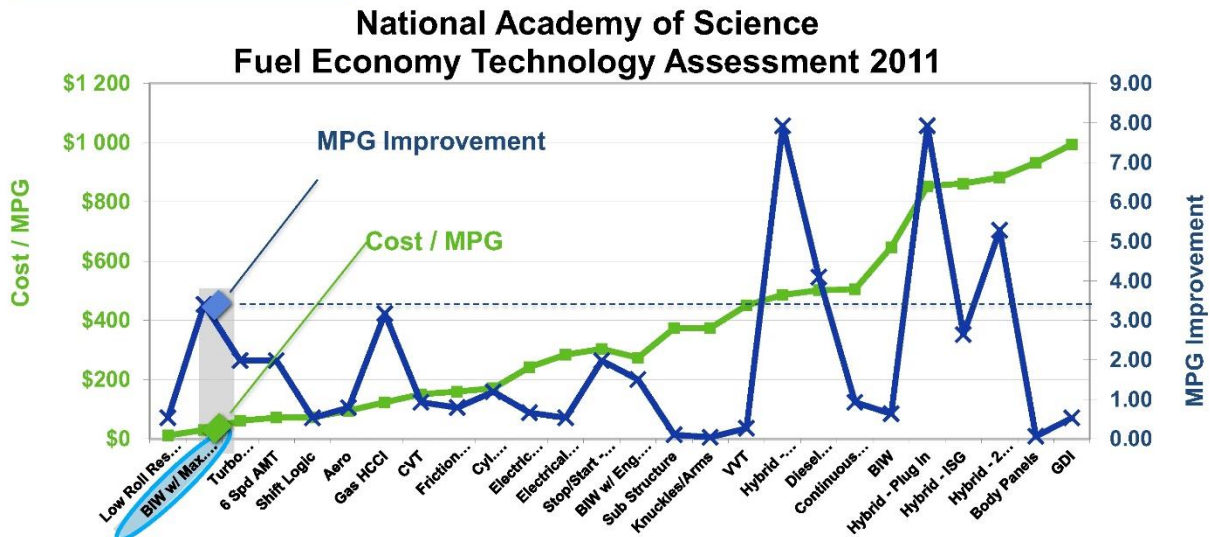
### All - Aluminum Range Rover (compared to steel predecessor)



6

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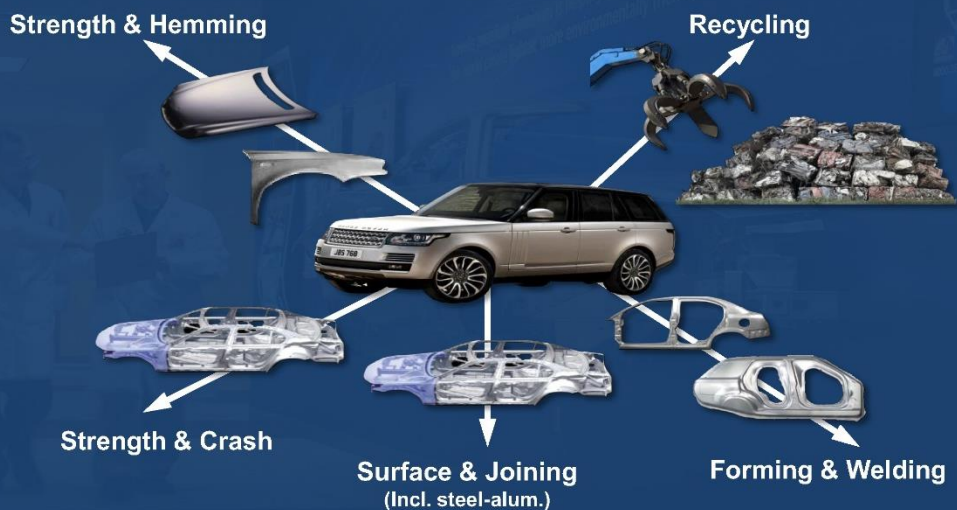
## Aluminum-based Mass Reduction Provides Cost Effective Fuel Economy



Source: US Aluminum Association

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## Alloy Development Directions



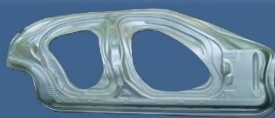
## Novelis Advanz™ Product Portfolio

	Exterior	Inner / Structure	Strength	Crash
In-Production	Advanz™ e600		Advanz™ c300	
	Advanz™ e170	Advanz™ s118	Advanz™ s615	
Launch Ready	Advanz™ e200	Advanz™ s200		
Standard Products	6016	5754	6111	
		5182		

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## Bodyside Evolution in Aluminum at JLR



**XJ (X350) Bodyside**  
 ▪ NG5754  
 ▪ 1.5mm



**XJ (X351) Bodyside**  
 ▪ AA6111  
 ▪ 1.2mm



**Range Rover Bodyside**  
 ▪ Advanz™ e170  
 ▪ 1.1mm



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Source: JLR presentation, Eurocarbody 2012, R. Lloyd, G. Moyce, S. Black, M. Rickards

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## Advanz™ e200 for Advanced Formability



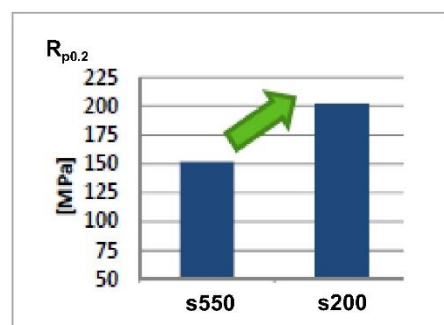
11

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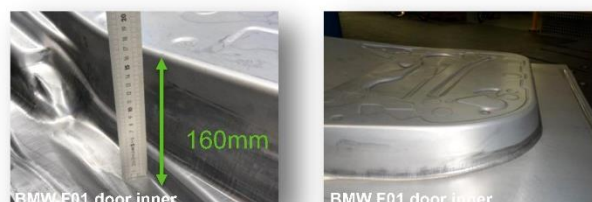
## Advanz™ s200 for Advanced Formability

### Benefits for door inners

- Down-gauging due to high strengthening in paint bake
- Uni-Alloy (6xxx series) approach for improved recycling
- Deep draw capability



Successful Forming Trials  
With Advanz™ s200



Doors and Closures in Car Body Engineering 2014

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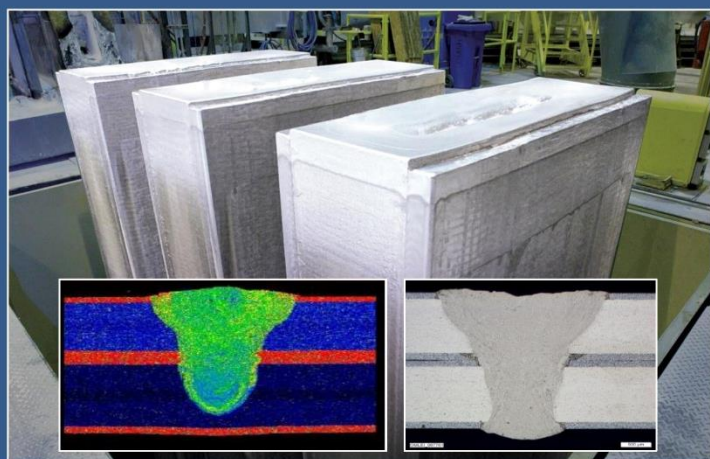
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## Solutions for Forming & High Speed Joining

# Novelis

### Advanz™ s200 is a key enabler for Remote Laser Welding

- Advanz™ s200 is weldable without filler metal
- Maintains the benefits of 6xxx monolithic products
- Approvals in progress with multiple automakers for several applications

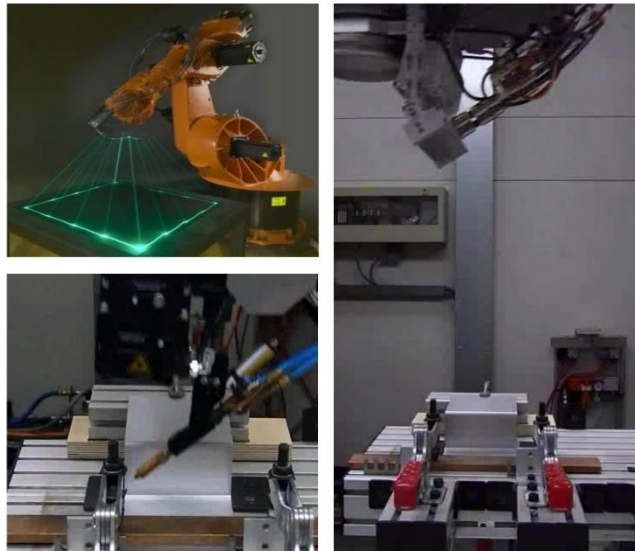


## Joining Productivity with Remote Laser Welding

- Much faster than conventional technique with filler metal
- Allows more complex welds
- Better weld sequence optimization

### The Challenge:

- 6xxx series alloys crack without a filler wire

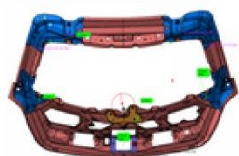


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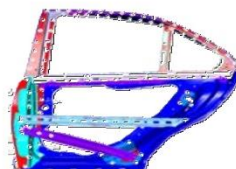
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## Opportunities for Advanz™ s200 and Remote Laser Welding

- One-side Assembly for many modules
- Potential reduction of adhesive bonding due to stiffness increase



Tailgate (110 welds/car)



Doors FD/RD (4 x 90 welds/car)



Sidewall inner (120 welds/car)

16

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Tailored Solutions for Material Utilization

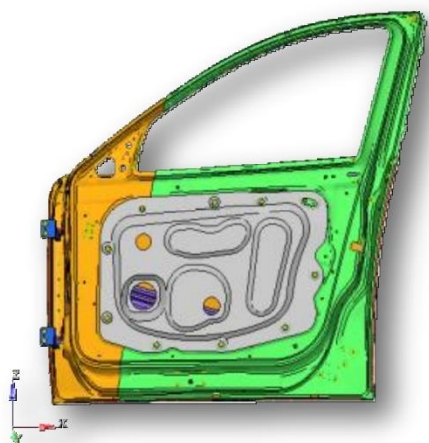
# Novelis

## Aluminum Tailored Blanks



DEVELOPMENT OF WELDING TECHNOLOGY	WELDING TECHNOLOGY & FORMING TECHNOLOGY VALIDATION	OEM APPROVAL PROCESS	SERIES PRODUCTION SET UP WITH OEM
			
2012	2013	Q1 2014	Q3 2014

## Tailored Aluminum Blanks – Door Structure Study



Cost Comparison Aluminum Assy vs. TAB®	
TAB®	
Δ NET WEIGHT	- 5 %
Δ GROSS WEIGHT	- 15 %
Δ VARIABLE COST	- 5 %
Δ INVESTMENT	- 39 %
WEIGHT ↓	COST ↓
PERFORMANCE ✓	

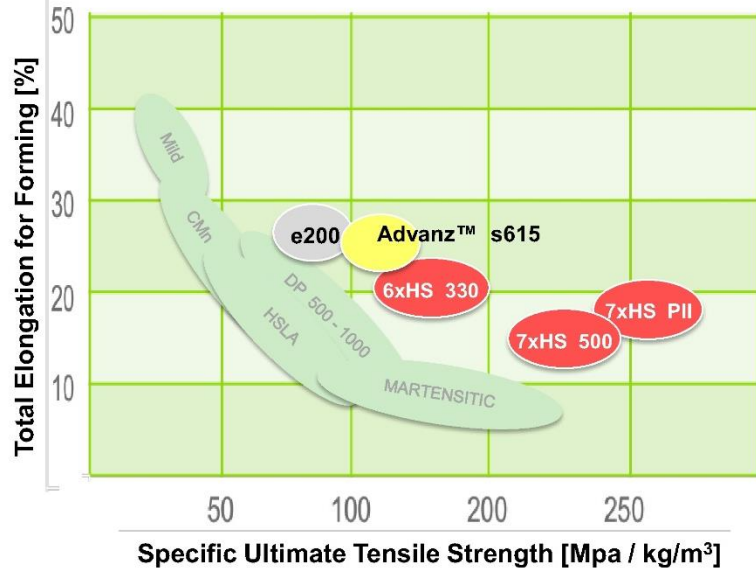
19

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## Alloys for Strength and Crash Energy

# Novelis

## High Strength Roadmap



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21

## Advanz™ c300 for Crash Energy Alloy



In comparison to 5754 equivalent part

- **20% Weight save** achieved – circa 6kg per vehicle
- **9% Cost save** per vehicle
- **12000 tonnes CO<sub>2</sub> reduced** from fleet tailpipe emissions

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## Strength Dominated Sheet Products

### Advanz™ s615

Status: In-production

- In-service T8x (2%+185°C 20min):  
**Yield Strength: 250 MPa**
- Post-form Artificially Aged (PFAA) Condition:  
**Yield Strength: 290 MPa**
- Designed for Strength-Toughness dominated parts
- PFAA material is rivet-able with Self-Piercing Rivets (SPRs)
- Avoid PFAA for cost reduction without excessive mass increase
- Developed to meet Ford's demanding 6HS2 specification but designed for a wide range of commercial applications



Advanz s615 launched in the 2015 Ford F-150

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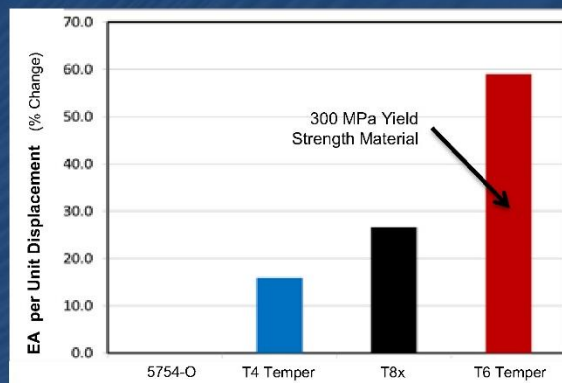
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## Advanz™ s615

### Static Axial Crush Test



### Energy Absorption (EA)



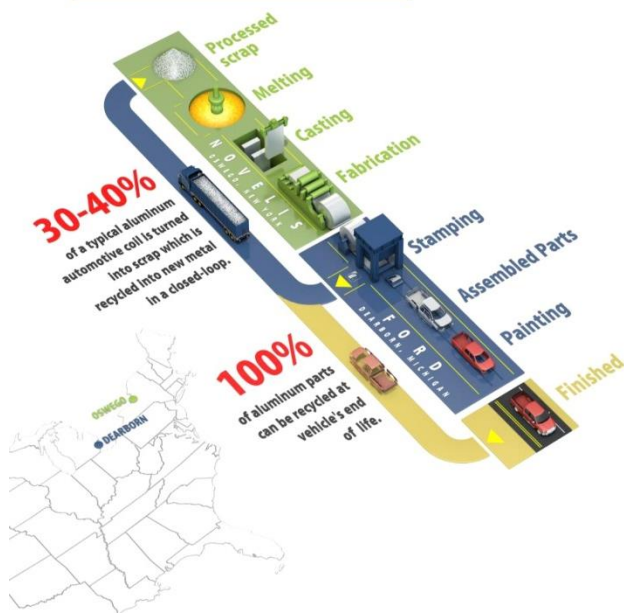
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## Closed Loop Recycling

# Novelis

## Closed-Loop System Drives Cost & CO<sub>2</sub> Efficiency



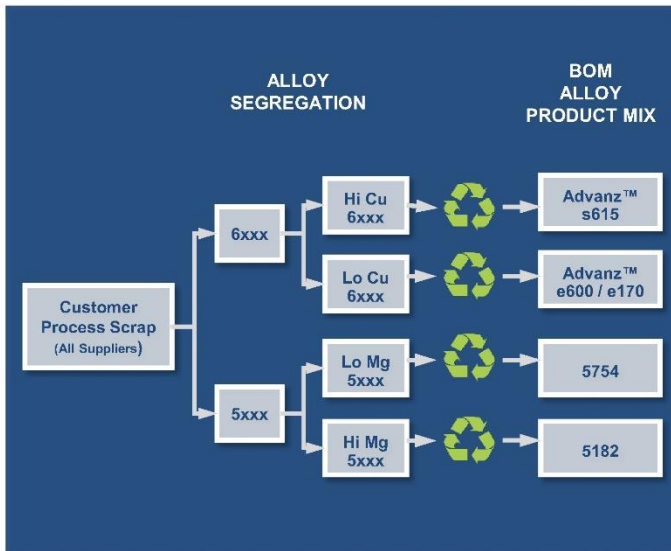
- Synchronize alloy selection with the stamping strategy and the closed-loop system strategy
- Espec. 5xxx - 6xxx alloy mix



Specially designed trucks deliver scrap back from Ford's stamping plant to Novelis to be recycled

**Not just aluminum, Novelis Aluminum.**

## Closed-Loop System Drives Cost & CO<sub>2</sub> Efficiency



27

- Early BOM visibility enables comprehensive trade studies and decisions
- We continue to enhance alloys for recycle content and breadth of application

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## Recycled Content Alloys



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### RC5754

- Developing higher recycled content auto alloys as part of company's sustainability commitment
- Jaguar XE is first all new car in the world to use this new, high recycled content aluminum alloy designed jointly by Novelis and Jaguar Land Rover for the automotive industry
- Launched in Europe this fall and arriving in North America in 2016

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## Adhesive Bonding Technology Innovation

# Novelis

### Novelis and Henkel Partner on Advanced Bonding Technology for High-Volume Aluminum Vehicles

- Global collaboration for Next-generation solutions for the aluminum industry adoption, *free from licensing*
- **Bonderite M-NT 8453**, the first product from the partnership
  - Designed to meet all customer requirements and fit all Automotive production lines globally
  - Key advantage: Versatility and cost-effectiveness for high volume, aluminum bonded structures

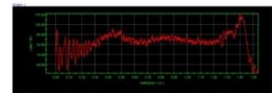


## Bonderite M-NT 8453

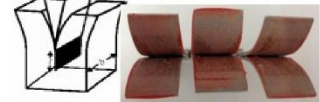
Ti, Zr fluorides and Henkel's proprietary polymer formulation provides industry-leading adhesion and corrosion resistance

Automaker Approvals	Tests Passed to Date	Production Versatility
<ul style="list-style-type: none"> <li>▪ Already approved by a global automaker</li> <li>▪ Undergoing approval testing with multiple global automakers</li> </ul>	<ul style="list-style-type: none"> <li>▪ The most severe Stress Durability testing in industry</li> <li>▪ Neutral Salt Spray - 20 weeks</li> <li>▪ Impact peel test</li> <li>▪ Resistance Spot Weld</li> <li>▪ E-coat/Paint and Corrosion</li> </ul>	<ul style="list-style-type: none"> <li>▪ Spray</li> <li>▪ Roll-on-dry-in-place</li> <li>▪ Immersion coating</li> </ul>

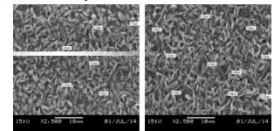
Fracture toughness results met OEM requirement



Cohesive failure



SEM Micrographs of Zn-P structure



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## Key Factors for Mass and Cost Efficiency

<ul style="list-style-type: none"> <li>▪ High Form and High Strength Alloys for Part Count and Thickness Reduction</li> <li>▪ Optimize Material Utilization</li> <li>▪ Establish a Closed-Loop System with High Recycled Content Products</li> <li>▪ High Speed Continuous Joining</li> <li>▪ SAFETY DURABILITY</li> </ul>	<ul style="list-style-type: none"> <li>▪ Harmonize "Fit for Service" Specs</li> <li>▪ DESIGN</li> </ul>	<ul style="list-style-type: none"> <li>▪ MANUFACTURING</li> </ul>	<ul style="list-style-type: none"> <li>▪ SUSTAINABILITY</li> </ul>
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**Dr. Jin Hou**  
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**<http://www.sapagroup.com/en/sapa-profiles-china/>**

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**TITLE**

**High performance Aluminium Alloys For Automotive Light-Weighting**

- ALUMINIUM SOLUTIONS AND HIGH
- PERFORMANCE ALLOYS FOR
- AUTOMOTIVE LIGHT-WEIGHTING

•JIN HOU, SAPA TECHNOLOGY

•ASIA AUTOMOTIVE LIGHTWEIGHT PROCUREMENT SYMPOSIUM  
JULY 6-8 2015, SHANGHAI

## •OUTLINE OF THE PRESENTATION

- A SHORT INTRODUCTION OF SAPA GROUP
- SAPA'S** ALUMINIUM EXTRUSIONS IN AUTOMOTIVE
- HIGH PERFORMANCE CRASH ALLOY
- EXTRUSION DESIGN IS EQUALLY IMPORTANT
- DEVELOPMENT IN FABRICATION TECHNOLOGIES OPEN NEW
- DESIGN POSSIBILITIES
- CONCLUDING REMARKS

**sapa:**

3

•YOU WILL FIND OUR PRODUCTS ALL AROUND YOU

			
•AT HOME	•IN YOUR OFFICE	•IN YOUR CAR	•TRAVELLING
<ul style="list-style-type: none"> <li>•Front doors</li> <li>Windows</li> <li>Stepladders</li> <li>Designer furniture</li> </ul>	<ul style="list-style-type: none"> <li>•Building construction</li> <li>Windows</li> <li>•Partition walls</li> <li>Computers</li> </ul>	<ul style="list-style-type: none"> <li>•Lots of components</li> <li>Accessories</li> <li>•Side impact bars</li> <li>•Airbag deployment doors</li> </ul>	<ul style="list-style-type: none"> <li>•Train carriage bodies</li> <li>Handrails</li> <li>•Luggage racks</li> </ul>

**sapa:**

4

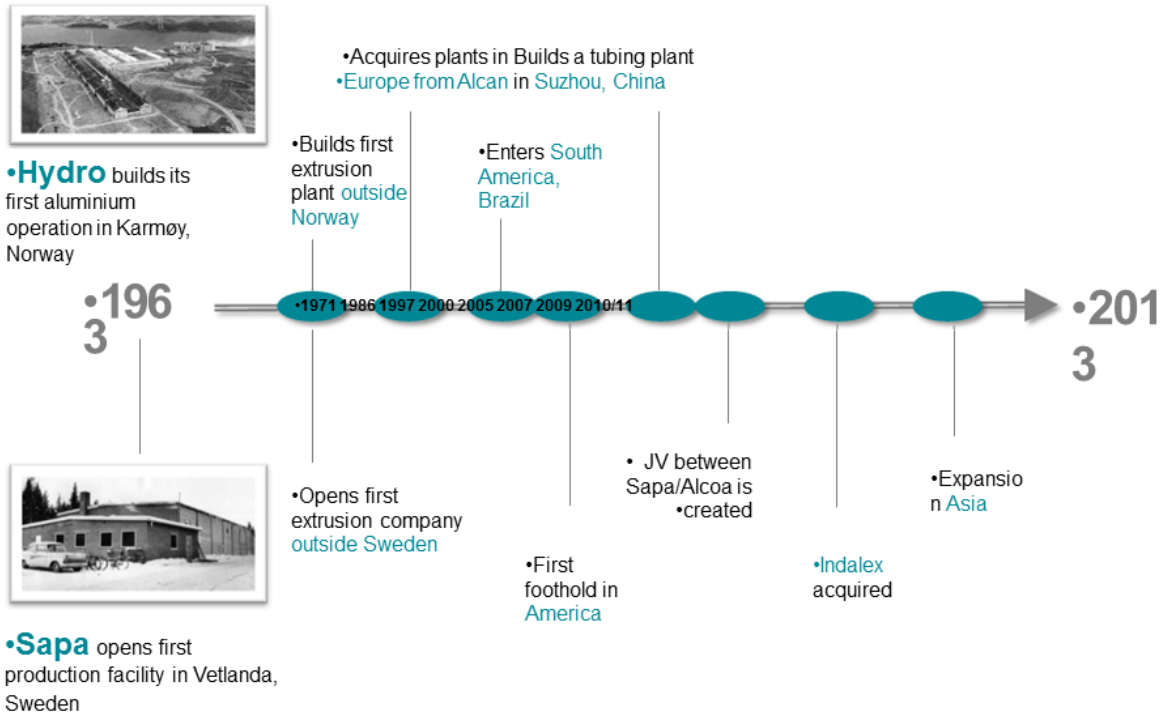
•WORKING ACROSS A BROAD PART OF THE ALUMINIUM  
•VALUE CHAIN



**sapa:**

5

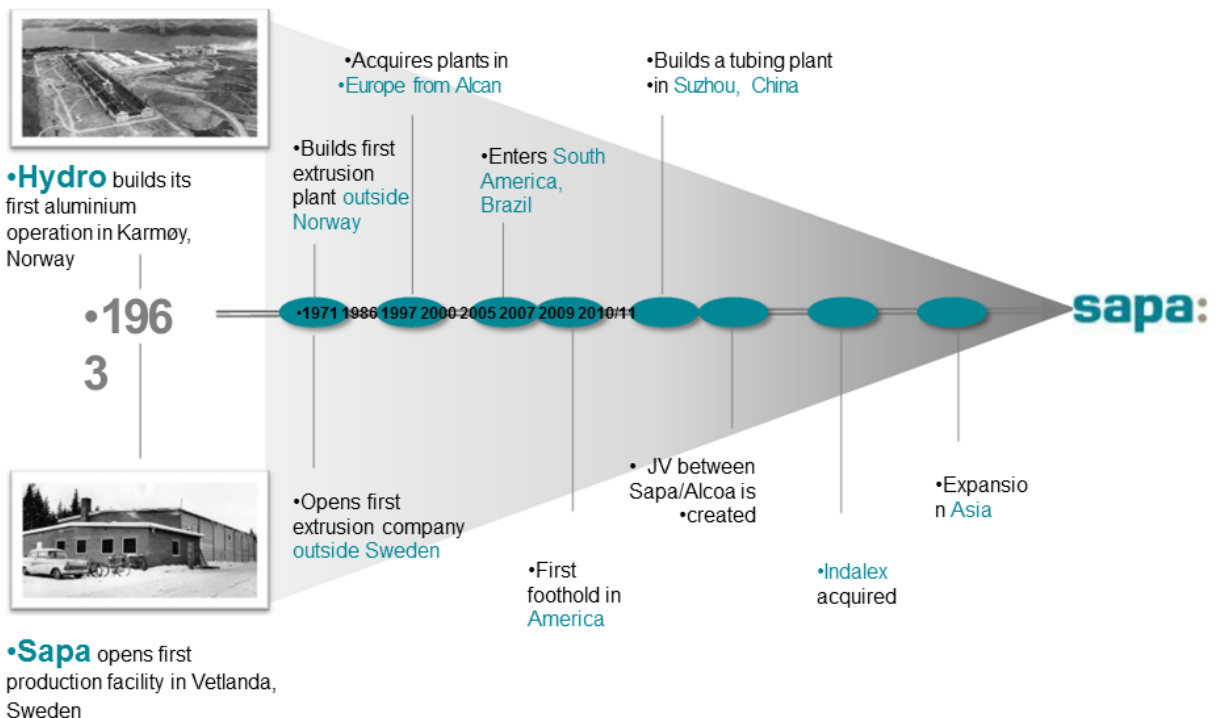
## •A 100 YEARS OF COMMON KNOWLEDGE...



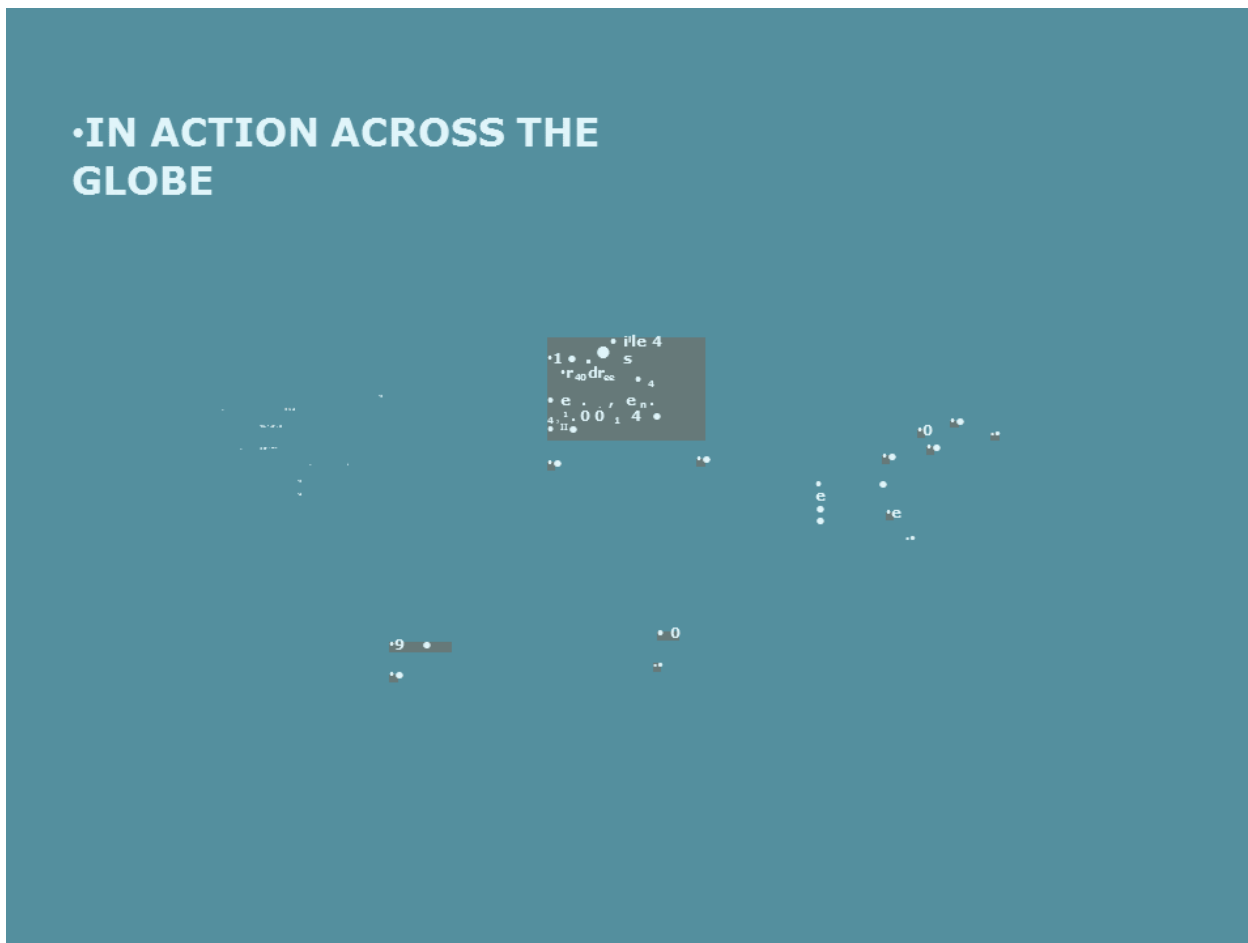
**sapa:**

6

## •...MERGED INTO A NEW COMPANY CALLED SAPA



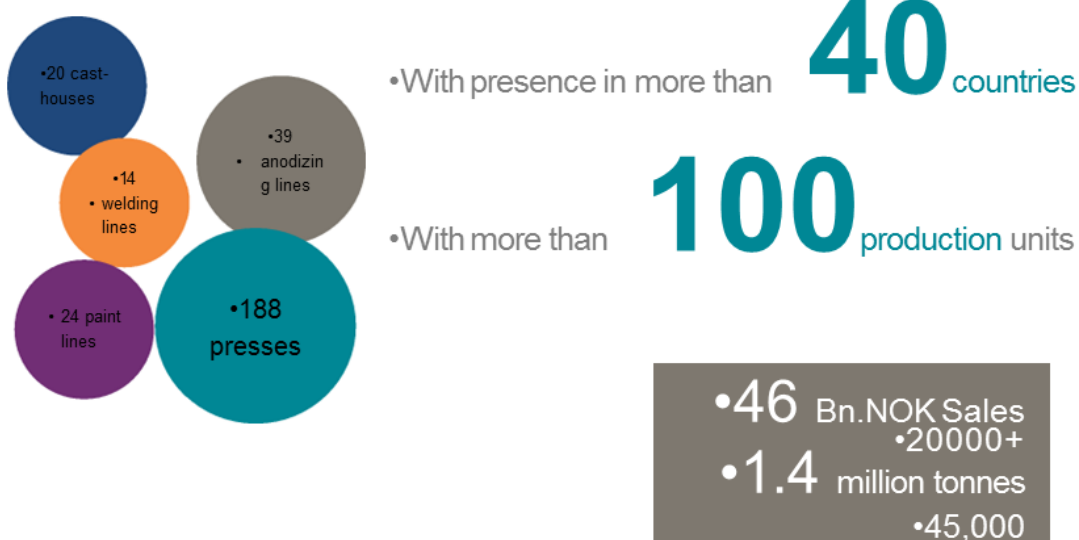
## •IN ACTION ACROSS THE GLOBE



**sapa:**

8

•MEETING CUSTOMER NEEDS – GLOBALLY AND LOCALLY

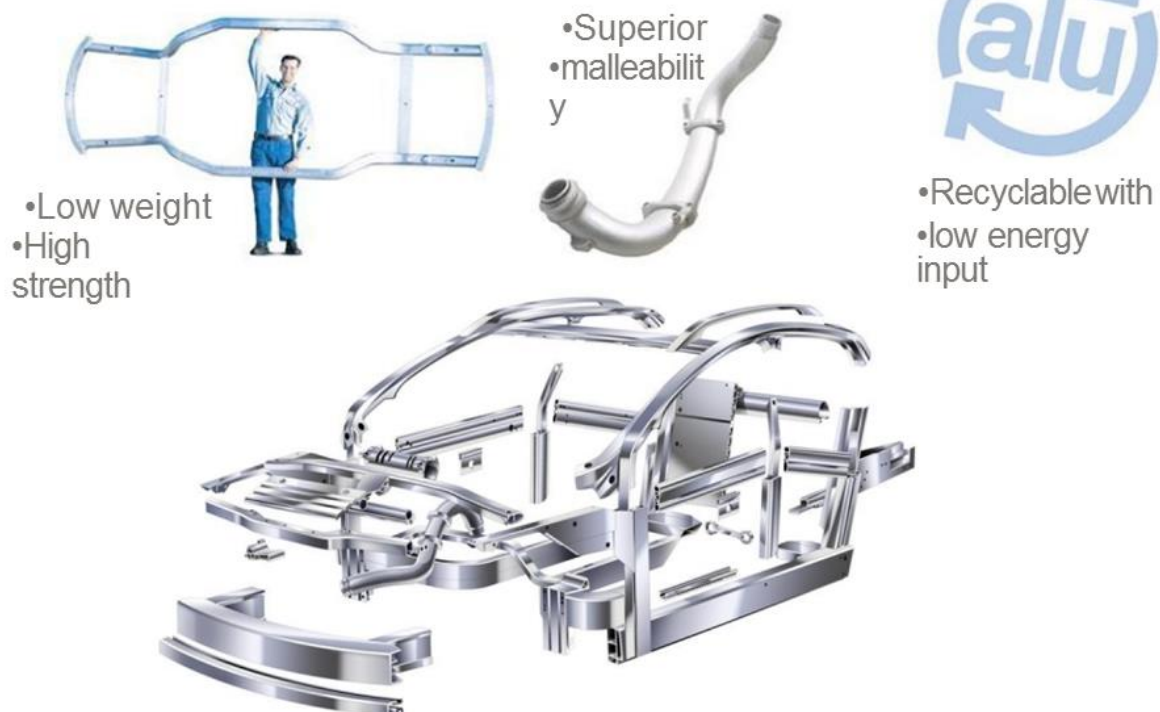


•**23,500** employees

## •OUTLINE OF THE PRESENTATION

- A SHORT INTRODUCTION OF SAPA GROUP
- SAPA'S ALUMINIUM EXTRUSIONS IN AUTOMOTIVE**
- HIGH PERFORMANCE CRASH ALLOY
- EXTRUSION DESIGN IS EQUALLY IMPORTANT
- DEVELOPMENT IN FABRICATION TECHNOLOGIES OPEN NEW
- DESIGN POSSIBILITIES
- CONCLUDING REMARKS

## **sapa:** •ALUMINIUM EXTRUSIONS HAVE UNIQUE PROPERTIES FOR ...



## sapa: .... LONGITUDINALS, CRASH BOXES AND BUMPERS

11

•Lower Energy Beam (located below bumper beam on SUV)

Product photo removed on hand-out slide

•Crash boxes and bumper solutions

•Bumper beam

## sapa: POWERTRAIN & DRIVELINE COMPONENTS <sup>12</sup>

•Engine mounts

•Fuel rails

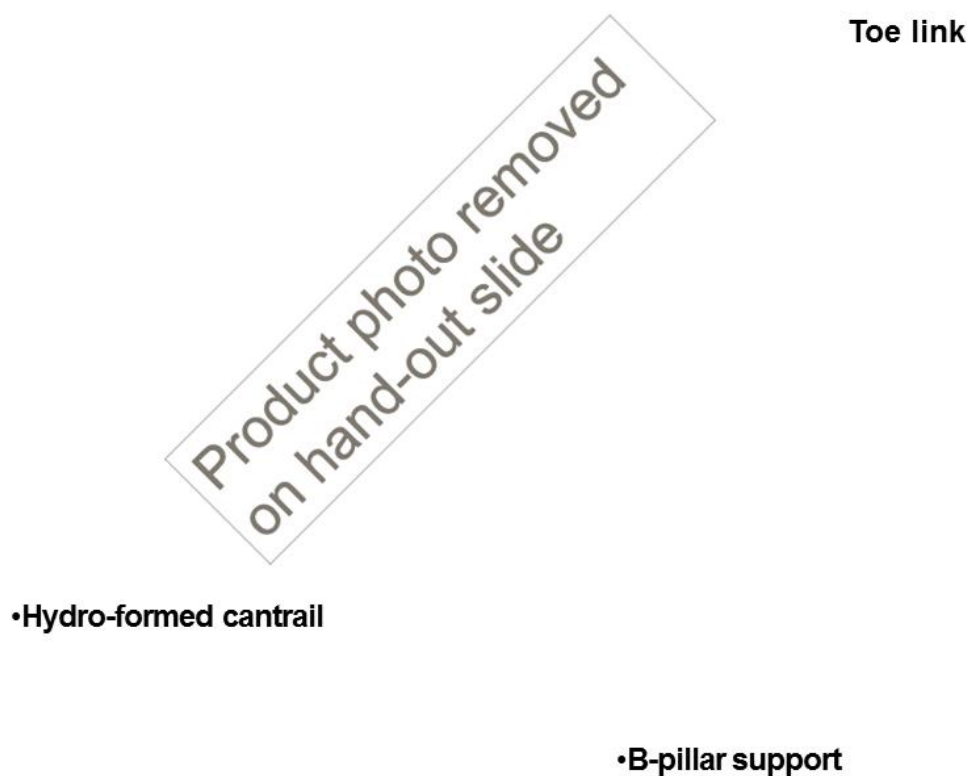
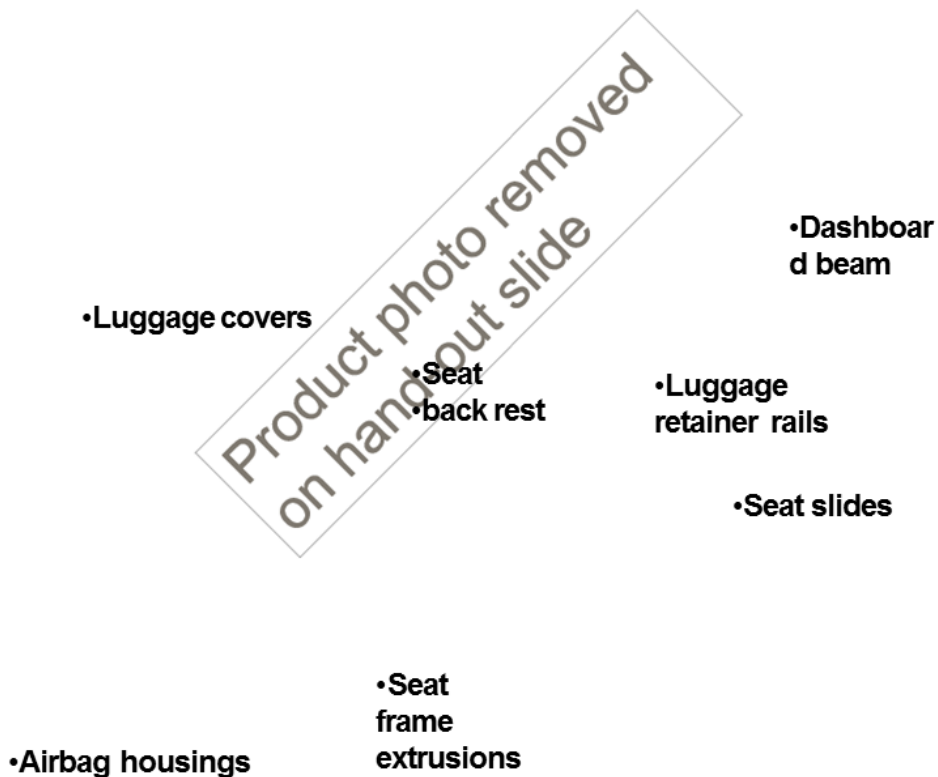
Product photo removed on hand-out slide

•Oil sump lath

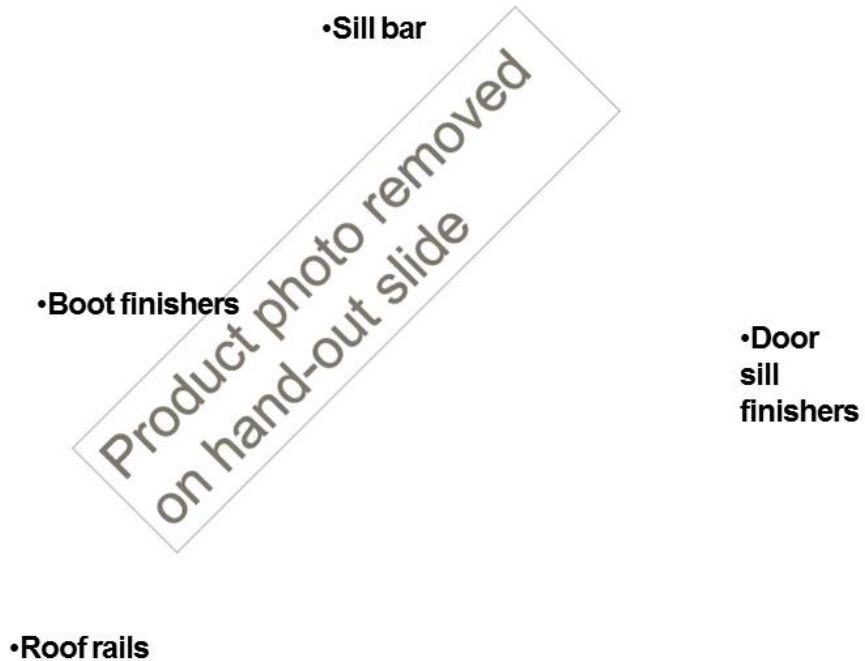
•Fan rings

•Turbo air intake

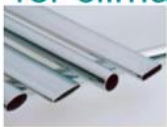
•Start heater



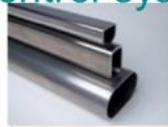




•Precision Tubing products are widely used in automotive HEX  
 •for climate control system, engine cooling and fluid lines



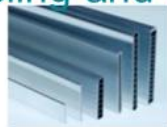
•Precision drawn tubes (PDT)  
 •For heaters, radiators, condensers, evaporators, coolant lines, oil coolant lines



•Welded tubes  
 •For structural components, radiators, heaters, charge air coolers, manifolds



•Welded tubes with inner fins  
 •For oil coolers



•Multi-port extrusions (MPE)  
 •For condensers, evaporators, oil coolers, charge air coolers, radiators and heaters – and can be supplied with HYBRAZ™ coating for direct CAB brazing



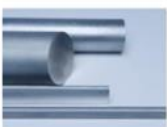
•HYCOT™ coated tubes  
 •For fuel lines, air-conditioning lines, power steering lines, coolant lines, oil cooling lines



•Aluminium cables



•Fuel cooler



•Forging stock (FOBS™)  
 •For extruded cold-drawn coiled rod for automotive components, such as screws and nuts



•Internal HX



•Welded Tubes: an alternative to cast parts for the customer

•Formed Structural Parts

Axle components

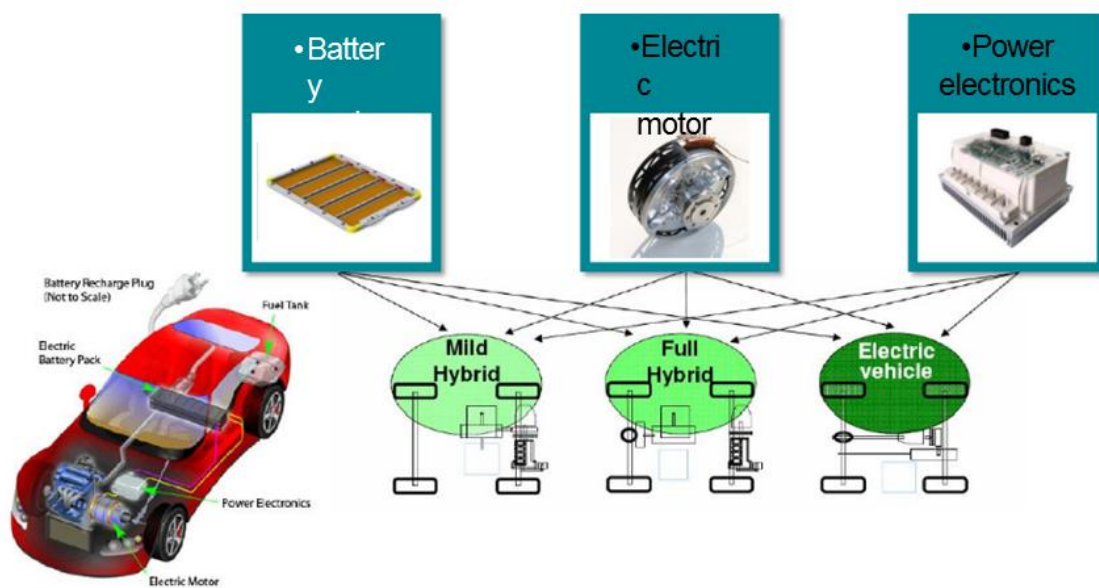
Body in white components

Drive shafts

Air suspension components (pistons and outer guidance)

Product photo removed on hand-out slide

•NEW APPLICATIONS FOR E-MOBILITY



## •BATTERY PACKS



## •SC-13 BATTERY CABLE SHOWS POTENTIAL FOR •WEIGHT AND COST SAVING

- SC-13 is an extruded solid aluminium rod
- As a standard the cable is HYCOT®
- coated with either PA, PE or XPE coatings

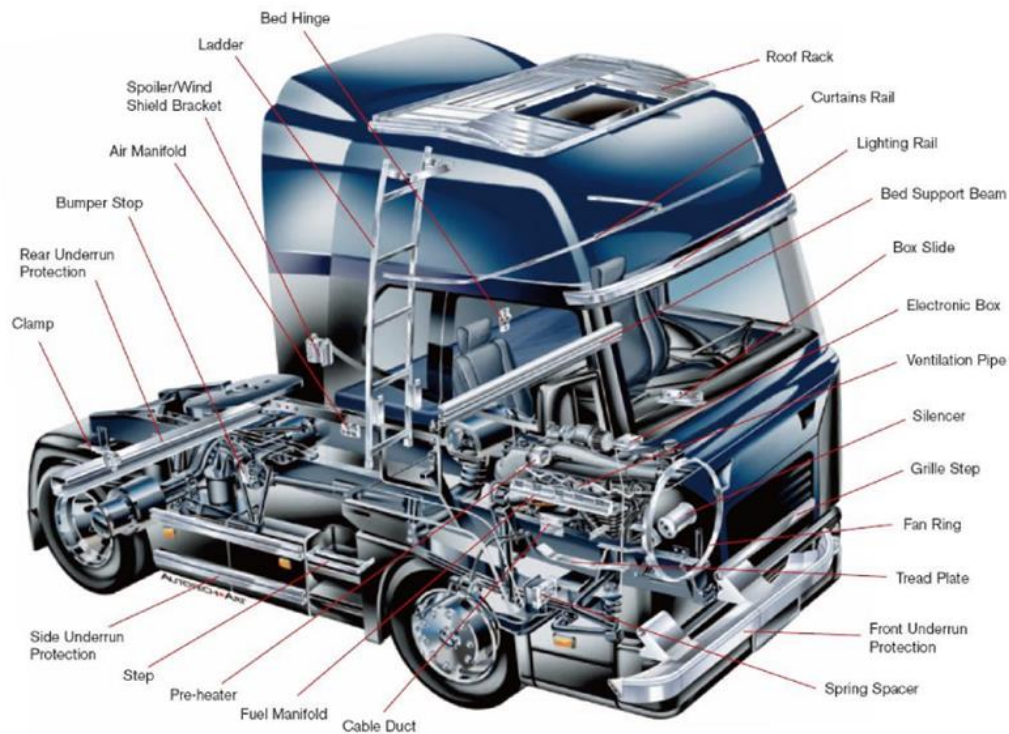
Delivering shapes of round, flat or oval,  
we deliver diameters up to Ø18 mm

Weighs 1/3 of the copper equivalent

Processability: Aluminium alloys allow  
specifically designed mechanical  
properties

Aluminium cabling increases the  
potential weight and cost savings





## •OUTLINE OF THE PRESENTATION

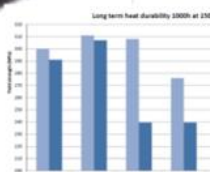
- A SHORT INTRODUCTION OF SAPA GROUP
- SAPA'S ALUMINIUM EXTRUSIONS IN AUTOMOTIVE
- HIGH PERFORMANCE CRASH ALLOYS
- EXTRUSION DESIGN IS EQUALLY IMPORTANT
- DEVELOPMENT IN FABRICATION TECHNOLOGIES OPEN NEW  
•DESIGN POSSIBILITIES
- CONCLUDING REMARKS

## sapa:

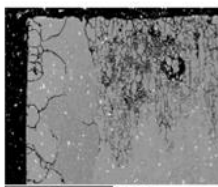
-23

### •DEMANDS FOR CRASH ALLOYS

- High strength and high ductility
- At the same time



- Short and long term heat durability
- Corrosion resistance



## sapa: SAME ALLOY DIFFERENT CRASH PERFORMANCE

24

•Same chemical composition Same chemical composition

•Sapa crash alloy Standard alloy



**sapa:** SAME STRENGTH AND SAME ELONGGATION  
DIFFERENT CRASH PERFORMANCE

25

•Sample A Sample B



•Rp0.2 / Rm / A5 / crush grade  
•~ 290 / 306 / 13-14 / 9 (Sample A), 3 (Sample B)

**sapa:** SAME STRENGTH AND SAME ELONGGATION  
DIFFERENT CRASH PERFORMANCE

26

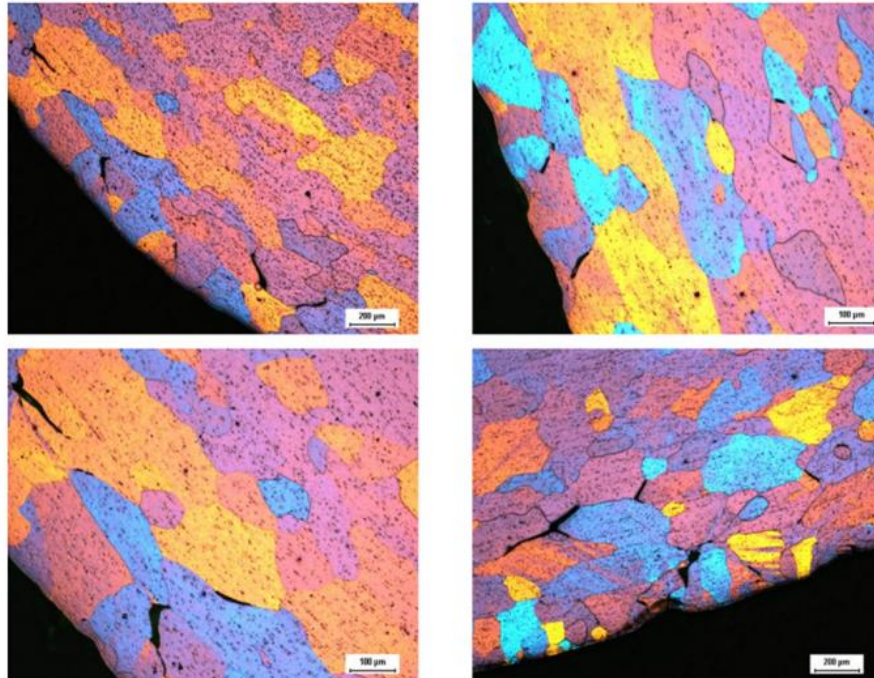
•Sample A Sample B



•Rp0.2 / Rm / A5 / crush grade  
•~ 290 / 306 / 13-14 / 9 (Sample A), 3 (Sample B)

## sapa: •INITIATION OF CRACKS AT •GRAIN BOUNDARIES

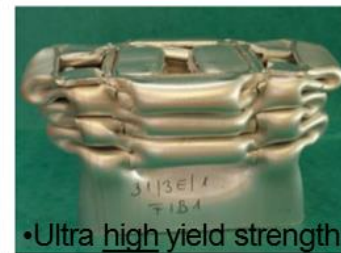
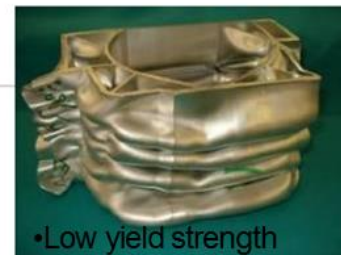
•27



## sapa: •MECHANICAL PROPERTIES

•28

- Basically, 4 different grades are defined, each grade often labelled according to lower yield strength limit



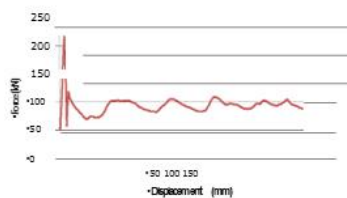
•Class	•R <sub>p0.2</sub> (MPa)	•R <sub>m</sub> (MPa)	•A <sub>5</sub> (%)
•Low yield strength •(C20)	•(180 -220) •200 – 240	•(≥205) •≥220	•(≥10) •≥11
•Mid yield strength •(C24)	•240 - 280	•≥260	•≥10
•High yield strength •(C28)	•280 - 330	•≥305	•≥10
•Ultra high yield strength •(C32)	•320 - 360	•≥340	•≥10

## sapa: EXAMPLE OF TESTING

29

### •Quasistatic compression testing

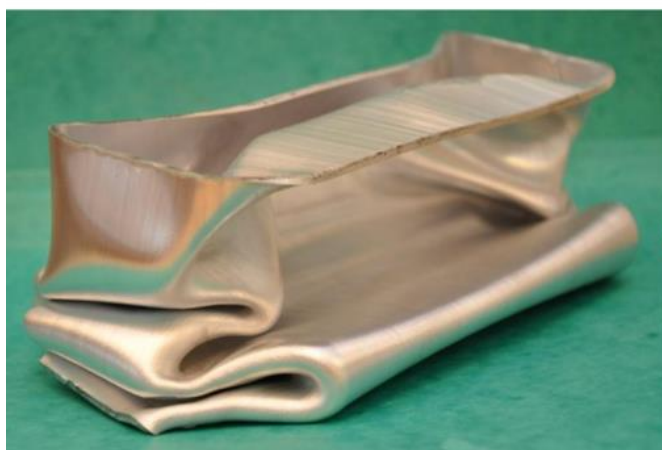
- Profiles compressed slowly in axial direction in a hydraulic press to  $\frac{1}{3}$  of original length (normally 300mm or 200mm original length)
- Load-displacement diagram shows the absorbed energy
- Visuell inspection and subjective evaluation of crash performance Small starter cracks are allowed



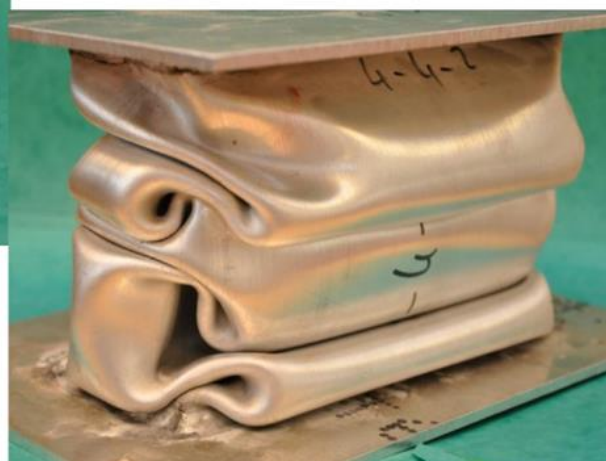
## sapa: EXAMPLE OF TESTING

30

### •QUASISTATIC VS DYNAMIC •COMPRESSION TESTING



- No difference in crash performance!





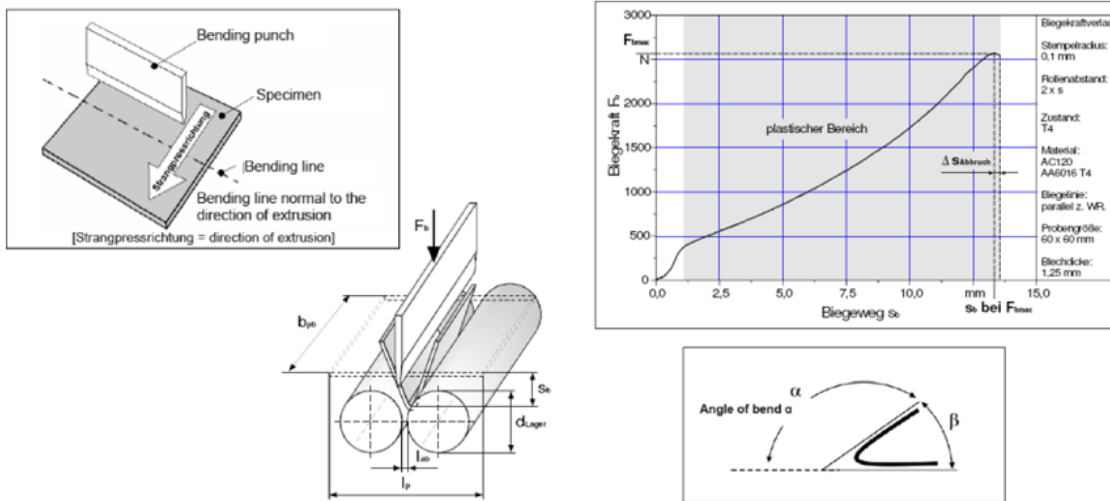
## sapa: EXAMPLE OF TESTING

31

### •3-point bending test

•A sample 60 x 60 mm is bent between two supporting rollers until the bending force is dropped by 15 N from max force

•The bending angle is measured and give a quantitative measure on the ductility



## sapa: EXAMPLE OF TESTING

32

### •3-point bending test results

•Orientation

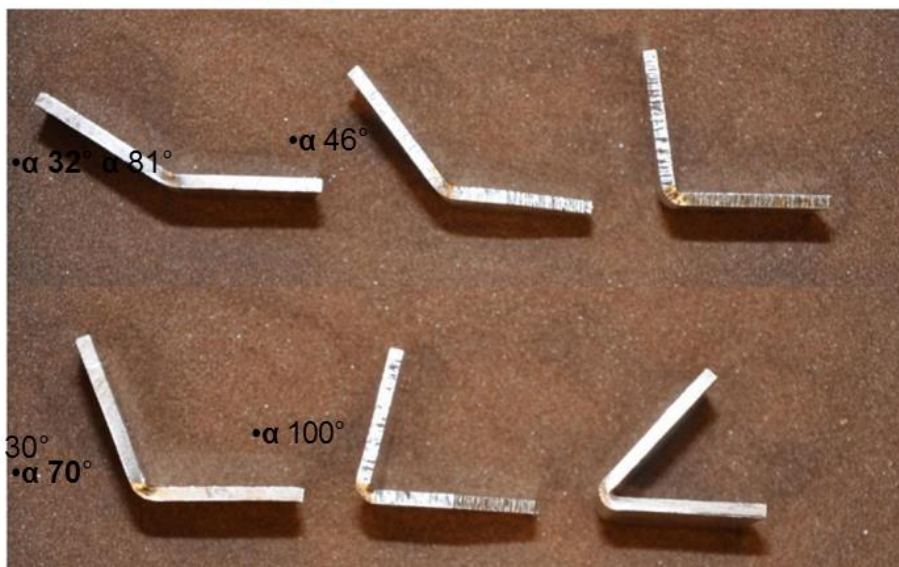
•90° 45° 0°

•(Rp0.2/Rm/A50)

•6063

•Poor results  
•(220/240/11)

•Good results  
•(230/245/11)



## •OUTLINE OF THE PRESENTATION

- A SHORT INTRODUCTION OF SAPA GROUP
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- HIGH PERFORMANCE CRASH ALLOY
- EXTRUSION DESIGN IS EQUALLY IMPORTANT
- DEVELOPMENT IN FABRICATION TECHNOLOGIES OPEN NEW
- DESIGN POSSIBILITIES
- CONCLUDING REMARKS

## **sapa:** DESIGN AND OPTIMIZATION BY SAPA

### •Design Optimization

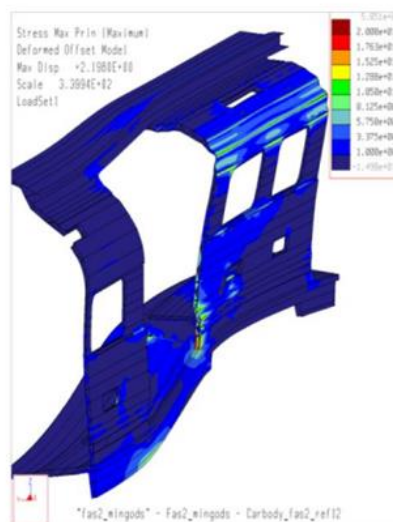
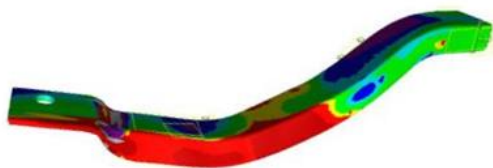


### •Crash Management



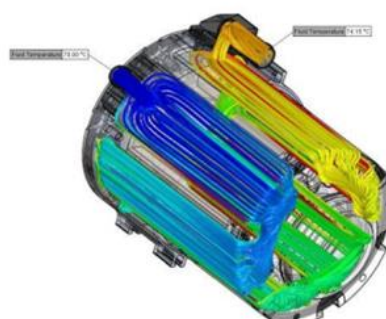
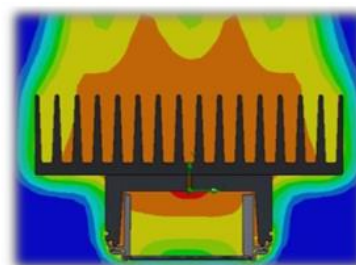
### •STRUCTURAL DESIGN & ANALYSIS

- FEA (static and dynamic)
- Assembly/Tolerance Analysis
- Snap-fit Design



### •THERMAL DESIGN & ANALYSIS

- Air Cooling
  - Forced or Natural Convection
- Liquid Cooling
  - Water or Coolant
- Key Optimization Goals
  - Heat Transfer
  - Pressure Drop
  - Extrudability
  - Weight
- Cost



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## sapa: SAPA'S FABRICATION PROCESSES

39

- 1 CNC
- 1 Bending
- 1 Cutting
- 1 Drilling
- 1 Punching
- 1 Milling
- 1 Hydroforming
- 1 Friction Stir Welding
- 1 MIG-TIG Welding
- 1 Vibration deburring
- 1 Assembly of accessories



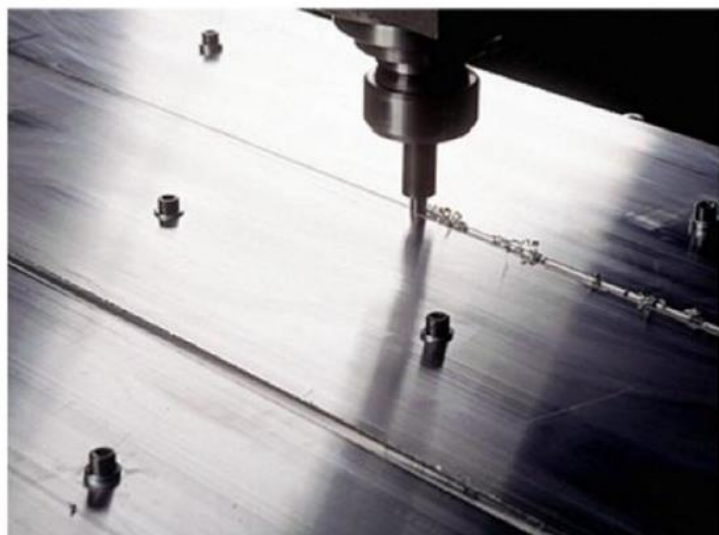
•... and much more

## sapa: ADVANCED TECHNOLOGIES

40

### •Friction Stir Welding

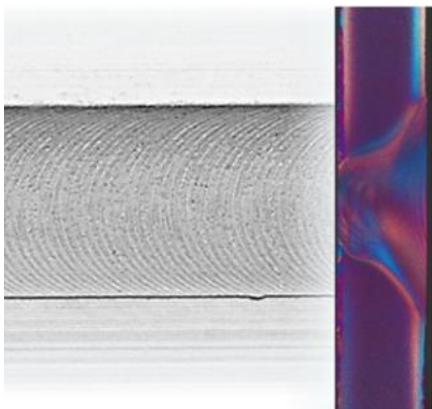
- . Unlimited size through fusing of smaller profiles
- . Molecular bonding with excellent properties
- . No melting, no warping, no change of properties



## sapa:

### • FRICTION STIR WELDING (FSW) PROCESS DEVELOPMENT

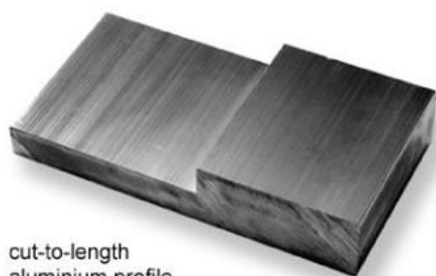
- Sapa part of the development
- since the beginning (early 90's)
- Sapa welds about 2 km/day



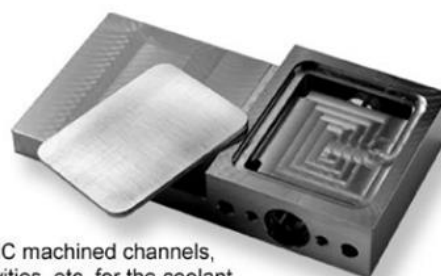
## sapa:

42

### • FRICTION STIR WELDING APPLIED • ON LIQUID COOLERS FOR ELECTRONICS



cut-to-length  
aluminium profile



CNC machined channels,  
cavities, etc. for the coolant



sealed by FSW  
in a CNC machine



machined, ground and  
surface treated – the finished component

**sapa:**

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- EV BATTERY COOLERS (LIQUID COOLING) BY SAPA
- USING ALUMINIUM EXTRUSIONS AND FSW

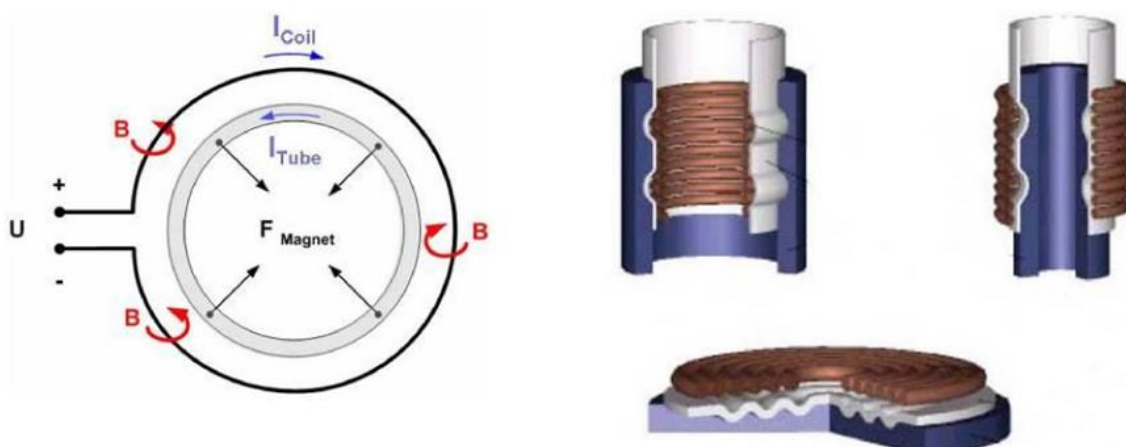
Product photo removed  
on hand-out slide

•Battery Cooling Plate

**sapa:** EMPT (Electro Magnetic Pulse Technology)

44

- Extremely fast forming and jointing with help of
- electro-magnetic induction pulse.



## sapa: •EMPT ADVANTAGES

•45

- No heat affected zone.
- Aluminium can be joint with e.g. plastic, steel, copper, etc.
- Very strong and reliable joint.

Product photo removed  
on hand-out slide

•Toe-link

•IP-beam structure

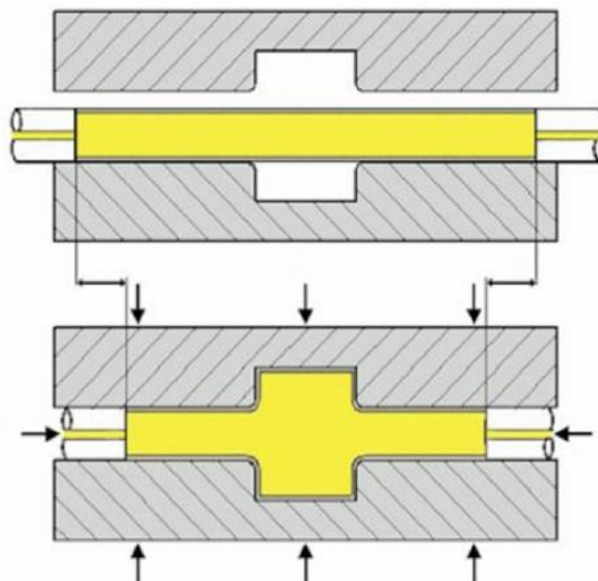
## sapa: HYDROFORMING PROCESS

46

- Pre-forming by bending (if necessary)
- Pre-forming in tool closure
- Final forming by high water pressure



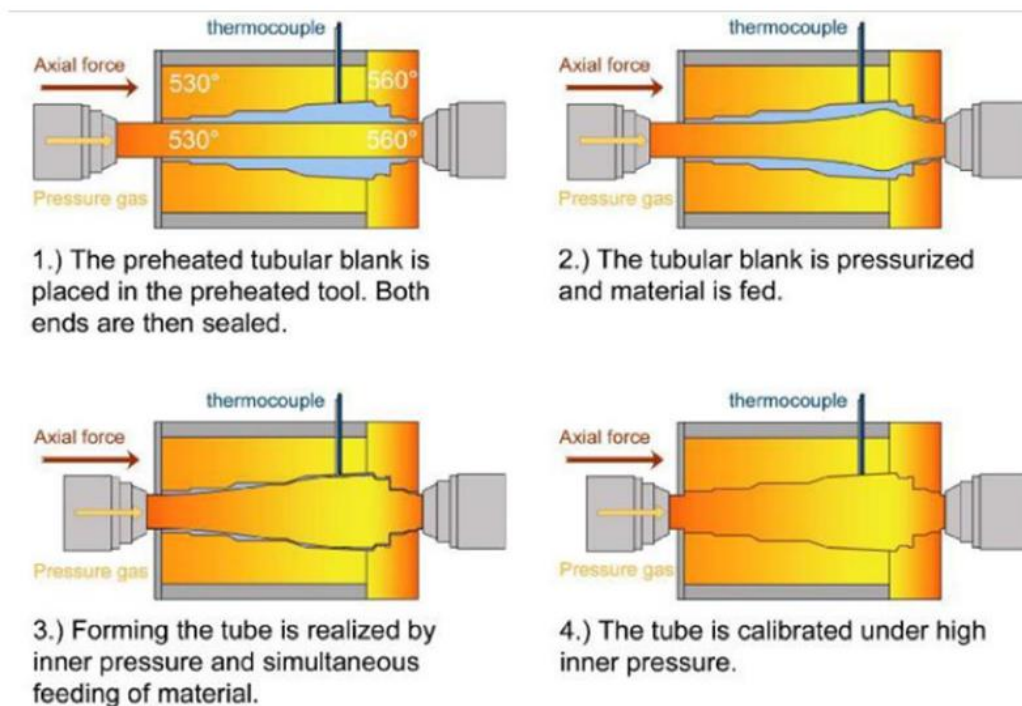
Air charge pipe, Volvo





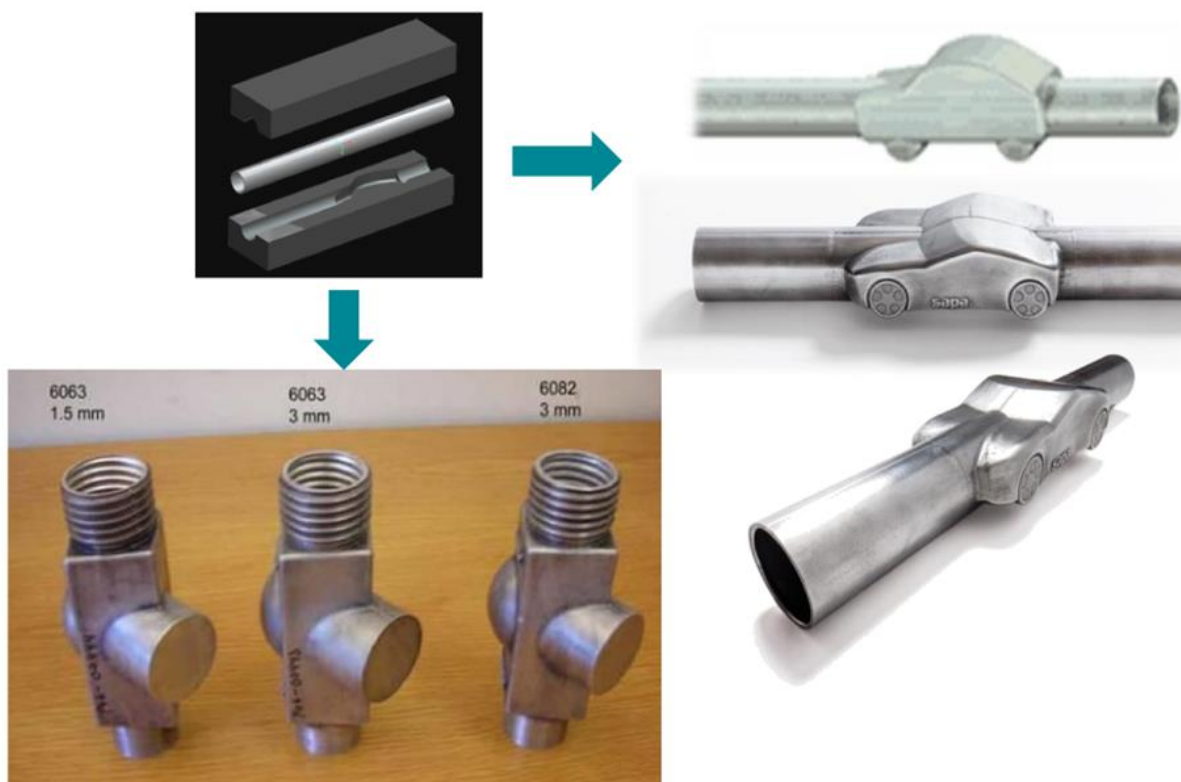
## sapa: •HOT GAS FORMING - THE PROCESS

•47



## sapa: •HOT GAS FORMING - POSSIBILITIES

•48

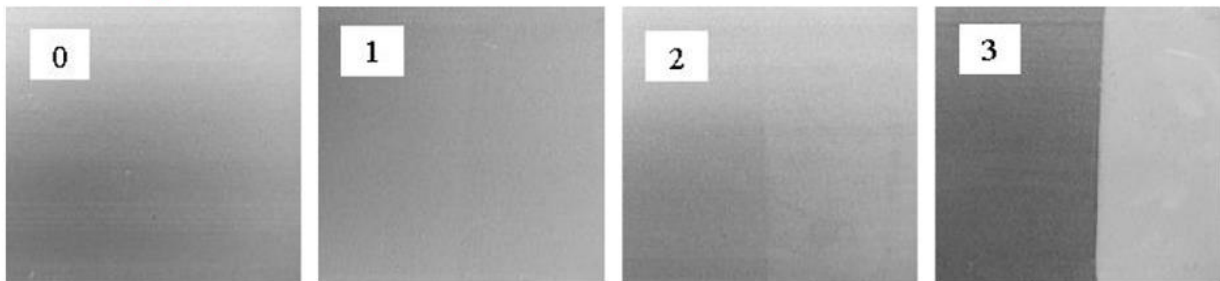


**sapa:**

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•EXCELLENT ALKALINE CORROSION RESISTANCE

•The new coating pass pH13.5 test!



•(Gradings in corrosion test)

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**sapa:**

50

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## •CONCLUDING REMARKS

- Needs and demands from automotive industry have always been
- key drivers for Sapa to develop new aluminium alloys, new
- applications and advanced manufacturing technologies
- With our global coverage, Sapa is aiming to become your preferred
- partner in automotive light-weighting, globally and locally
- Over 1000 engineers in Sapa are ready to answer your calls and
- serve you with any questions related to aluminium extrusions and its
- application in automotive
- Dedicated R&D and product development resources in Sapa are
- willing to work with you side-by-side to meet the challenge of
- automotive light-weighting

Welcome To Visit  
Sapa Booth at

Aluminium China 2015

**Sapa booth No. 3D40**

•More info

•[www.sapagroup.com](http://www.sapagroup.com)

R&D and technical questions

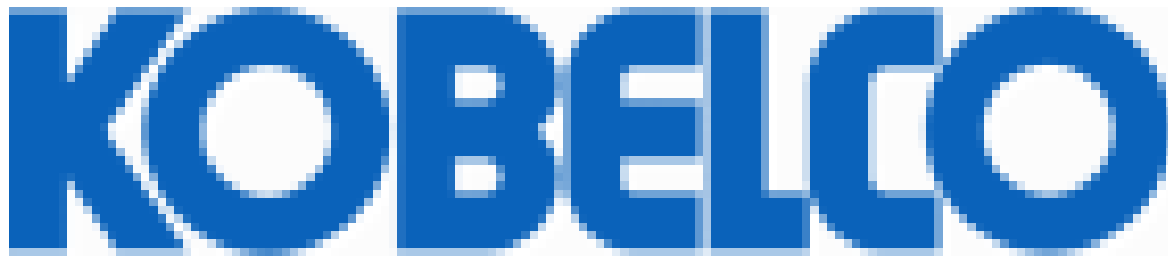
[jan.strid@sapagroup.com](mailto:jan.strid@sapagroup.com) (Global)

[jin.hou@sapagroup.com](mailto:jin.hou@sapagroup.com) (Asia)

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[dirk.schneider@sapagroup.com](mailto:dirk.schneider@sapagroup.com) (Global)

[lihui.song@sapagroup.com](mailto:lihui.song@sapagroup.com) (China)



**Mr. Yoshikazu Mukai**  
**Senior Vice Presiden Aluminum &**  
**Copper Department**

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**<http://www.kobelco.co.jp>**

## **TITLE**

**Kobe's R&D Activities For Automobile Lightweighting**

## **ABSTRACT**

R&D strategy

- Kobe's 6xxx ,5xxx alloy and newly developed alloy
- Newly developped pedestrian protect food structure
- PP resin and Aluminum injection joining and newly developed mechanical joining



## Kobe's R&D Activities for Automotive Lightweighting

Yoshikazu Mukai  
Kobelco Automotive Aluminum Rolled Products (China) Co.,Ltd  
神钢汽车铝材(天津)有限公司  
KOBE STEEL GROUP

*Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Symposium Shanghai,China*

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### Contents

#### ◆ KOBELCO STEEL company overview

Introduction of Kobe Steel

#### ◆ R&D topics

1) Research and Development Strategy.

2) Material

- Newly developed 6xxx alloy with high paint bake response

3) Structure design

- Pedestrian protection aluminum hood development
- Thermal deformation CAE for Aluminum parts

4) Forming & Joining

- Electromagnetic forming technology for Bumper system.
- Newly developed mechanical joining
- Technology of Aluminum & PP-resin direct joining

5) Solution for NV problem caused by Lightweighting

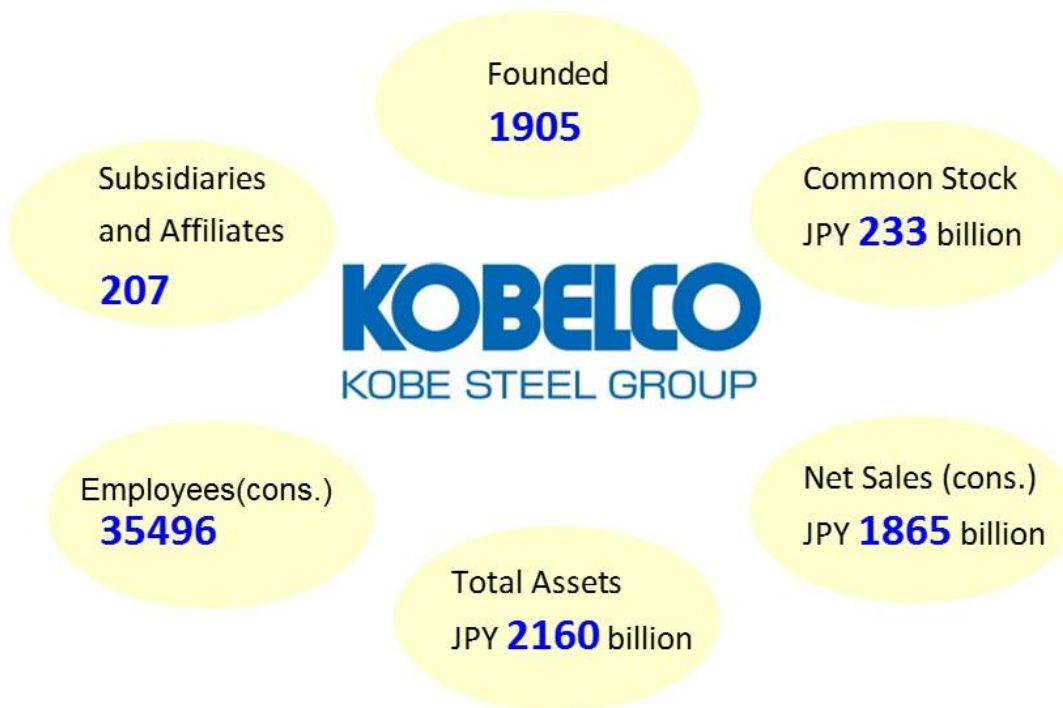
#### ◆ Global foot print

Flat rolled, Forged, Extruded products supply scheme  
in Japan, China, US, Europe

*Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Symposium Shanghai,China*



## KOBE STEEL Overview



Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Symposium Shanghai, China



## KOBE STEEL Overview



Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Symposium Shanghai, China



## Automotive applications with Kobe Steel Products

**High Strength Steel**, Valve Springs

**High Strength Steel**, Gears

**High Strength Steel**, Body Structures

**High Strength Steel**, Suspension Springs  
**Forged aluminium**, Suspension arms

**Aluminum Alloy**, Heat Exchangers

**Aluminum Alloy**, Closure Panels

**Copper Alloy**, Electrical Terminals

**High Strength Steel**, Bolts

**Steel Cord** Wire Rods

5  
**KOBELCO**  
KOBELCO STEEL GROUP

*Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Simposium Shanghai, China*

## Contribution to Automotive Lightweighting

KOBE STEEL have a potential to support the lightweighting, with supplying the Flat rolled, Forged, Extruded products.

Engine hood

Trunk lid

Subframe

Side frame (crash absorbing)

Side sill

Bumper beam

Suspension forging

Door beam (with brackets)

*Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Simposium Shanghai, China*

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Flat rolled, Forged, Extruded products supply scheme  
in Japan, China, US, Europe

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## 1) R&D strategy

### What's the Problems when using AL?

#### Difference between steel and aluminum

(↓: Inferior to Steel, ↑: **Superior to Steel**)

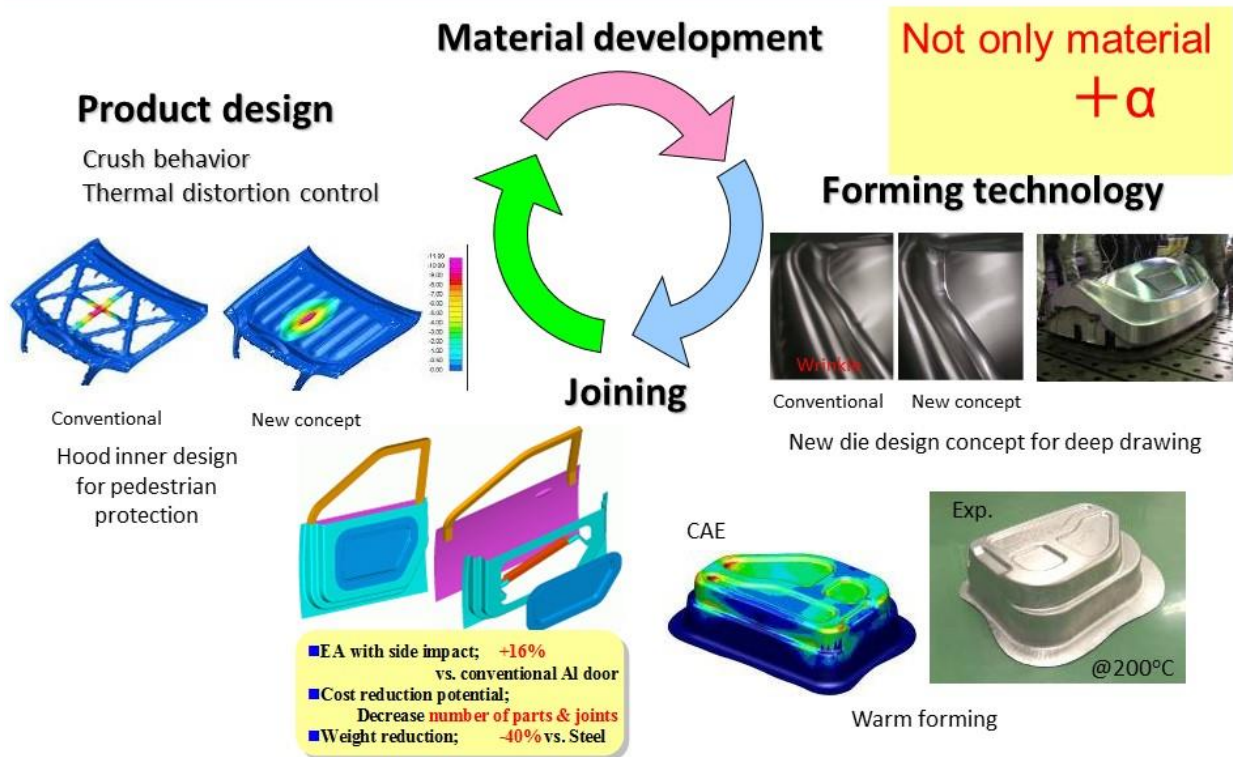
- **Formability, Weldability** : Aluminum ↓
- **Surface treatment handling** : Aluminum ↓
- **Surface defect sensitivity** : Aluminum ↓  
(Easily deformed)
- **Material cost**: Aluminum ↓ (but scrap can be sold higher than steel)
- **Weight** : Aluminum ↑ (**Lighter**)

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## 1) R&D strategy



New door concept study

Y.Mukai, Asia 2015 6<sup>th</sup>-8<sup>th</sup> of Jul. Automotive Lightweight Procurement Symposium Shanghai, China

## 2) New 6xxx alloy development

### Material List

Materials	AA	Applications	Definitions	Mechanical properties				
				TS (MPa)	YS (MPa)	EL (%)	PB-YS* (MPa)	
6000 series	6K21	6022	Outer/ Inner	Well balanced PB alloy	240	125	29	200
			Inner	Better formability (very low PB)	250	130	30	165
	6C16	6016	Outer	Well balanced PB alloy	220	110	29	190
			Inner	Better formability (very low PB)	230	115	30	160
	6C44	6014	Outer	Well balanced PB alloy	220	110	29	190
	6C32	6111	Outer/ Inner	Better formability PB alloy than 6K21	260	135	29	210
6C31	-	Inner	Excellent formability, only for inner (very low PB)	275	130	32	165	
5000 series	5J32	5022	Outer/ Inner	Excellent formability, high Cu volume (susceptible for corrosion)	285	135	33	155
	5J30	5023	Outer/ Inner	Excellent formability, high Cu volume (susceptible for corrosion)	275	135	30	155
	5182	5182	Inner	In common	270	125	29	140
	5052	5052	Inner	In common	195	90	29	140

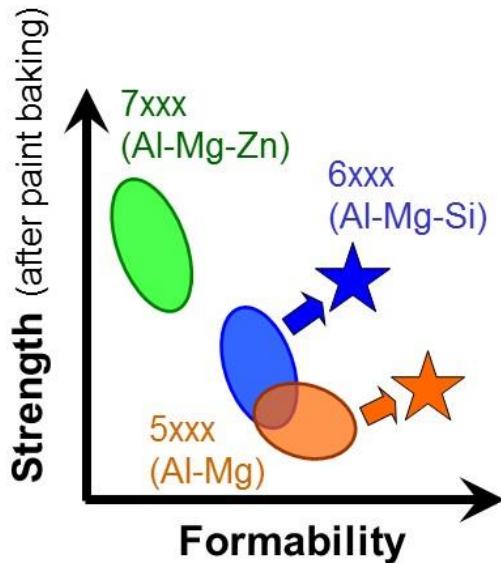
PB: Paint Bake

\*1) 2% pre-strain, at 170 °C for 20 minutes

\*2) Specimen Dimension: JIS Z2201 #5

## 2) New 6xxx alloy development

To improve required performance for 6xxx,  
Kobe Steel is working continuously with our customers.



Application	Key words
Panel	Formability <b>Paint bake response</b> Hemming Natural aging control Roping free
Structural parts	Strength Energy absorption

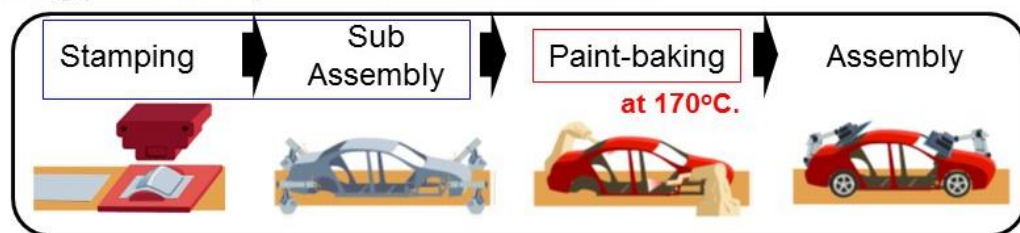
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11  
**KOBELCO**  
KOBELCO STEEL GROUP

## Motivation of Paint Bake Response improvement

- Manufacturing process of parts at car manufacturers

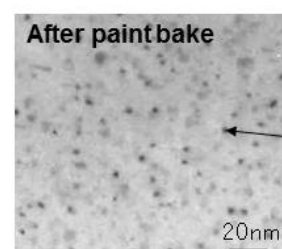
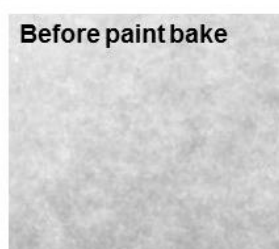


- Mechanical properties of Al sheets

Lower strength for better hemming performance.

Higher Paint Bake Response even at low temperature.

- Microstructure (Transmission Electron Micrograph)



Strengthening precipitates

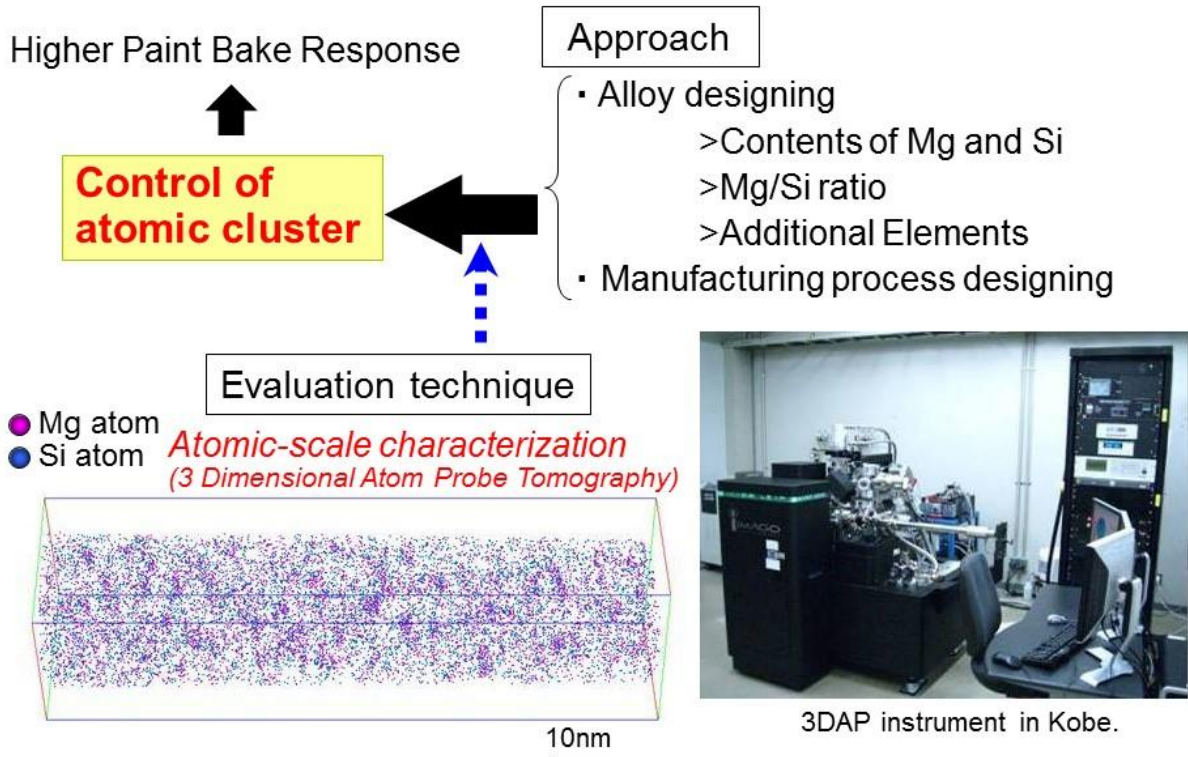
20nm

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## Evaluation of atomic cluster distribution



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## Properties of Developed 6xxx alloy

Chemical composition & mechanical properties of test materials (Lab)

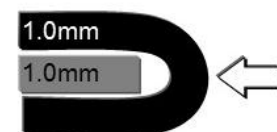
	Chemical composition (wt%)				Tensile property: JIS13A Direction 0° RD						
					Before paint bake					After Bake	
	Si	Mg	Cu	Addi-tive	R <sub>m</sub> MPa	R <sub>p0.2</sub> <sup>*1</sup> MPa	R <sub>p0.2</sub> /R <sub>m</sub>	A <sub>80</sub> %	n-value (5%)	R <sub>p0.2</sub> <sup>*2</sup> MPa	ΔBH (*2-*1) MPa
Conventional	1.0	0.4	0.15	-	237	116	0.49	27	0.30	215	99
Developed	<b>0.8</b>	<b>0.4</b>	-	<b>0.06</b>	186	79	<b>0.42</b>	25	<b>0.34</b>	199	<b>120</b>

Bending test results (R=0.5, 180 deg.)

Paint bake: 2%st.+185°C,20min

Natural aging for 1 month

	0°	90°
Conventional		
Developed		



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## Paint Bake Response at 170°C

Newly developed 6xxx alloy showed;

-better hemming performance.

-higher Paint Bake Response even at low temp (170°C).

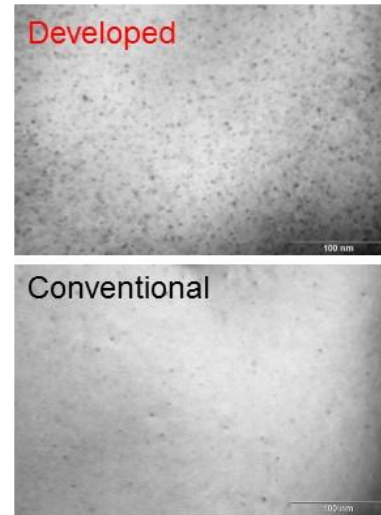
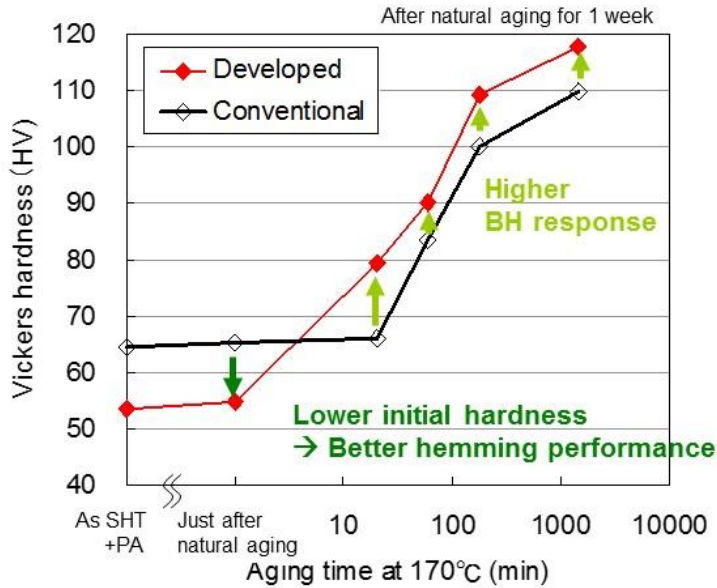


Fig. TEM observations for the samples, aged at 170°C for after 20 min.

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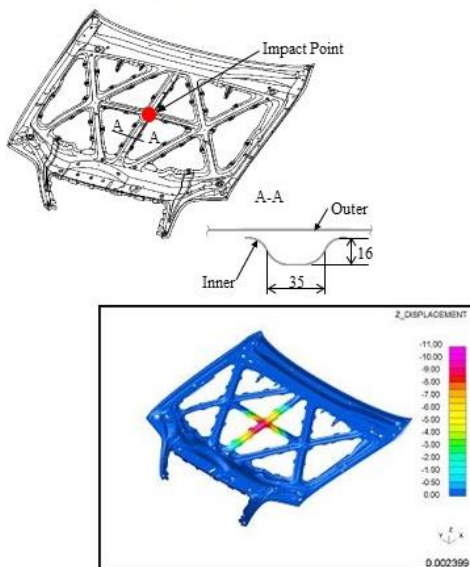
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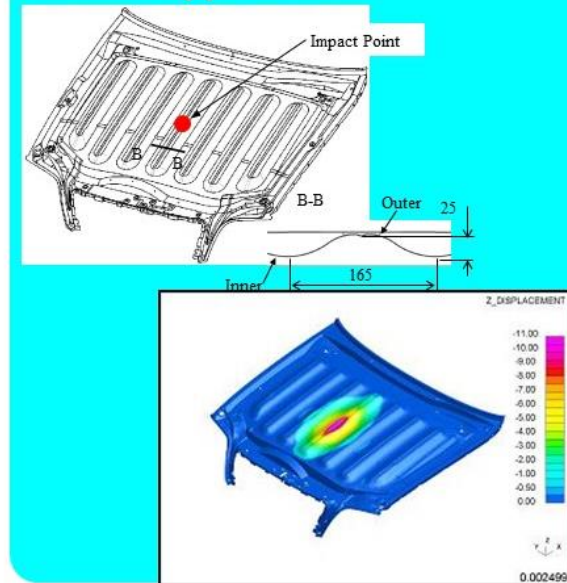
## 3) Structure Design

### ● Pedestrian protection Aluminum Hood

#### Beam-type inner



#### Wave-type inner



(The source: IBEC '03 (International Body Engineering Conference & Exposition), No. 20037070)

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## ● Newly developed wave-type inner Structure

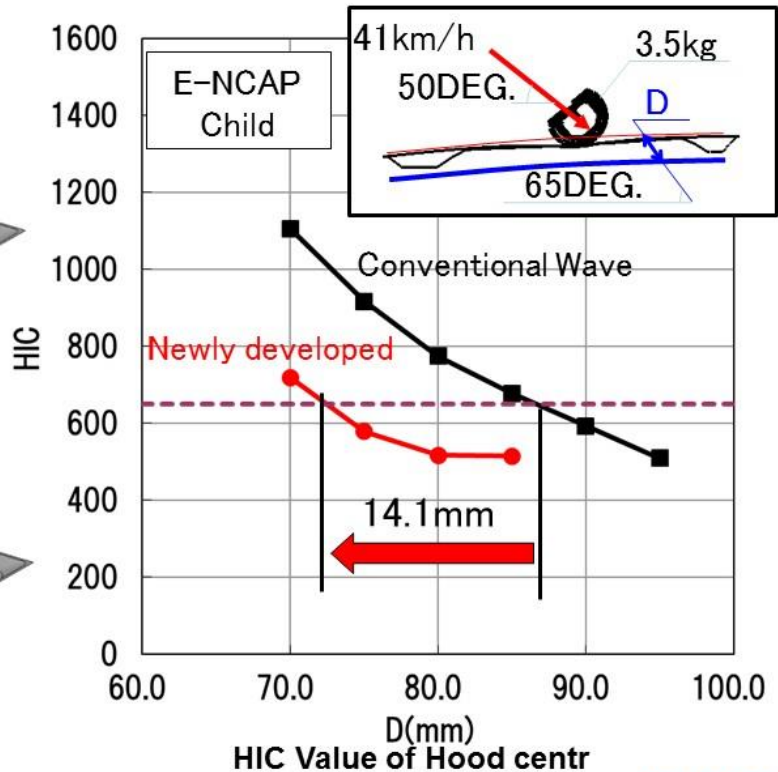
Conventional Wave



Newly developed



OTR:  $t=1.0 \Rightarrow 0.9\text{mm}$   
 INR:  $t=0.9\text{mm} \Rightarrow 0.8\text{mm}$



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## ● Examples of Wave-type Inner Hood

After 2003 ~ Wave-type increasing

※Kobe proposed



Toyota Crown 2004 ※



Toyota Crown 2008 ※



Mitsubishi Lancer Evo. X 2007



Lexus HS ※



Lexus GS 2012



Infiniti Q50 2014※

⇒ Further improvements requested !

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## 3) Structure design

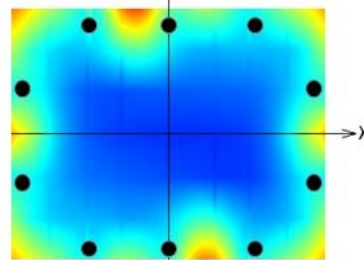
### ● Thermal deformation CAE for Aluminum parts : Roof(Al)-Side panel(Steel) structure

#### ▪ Identification by experiment

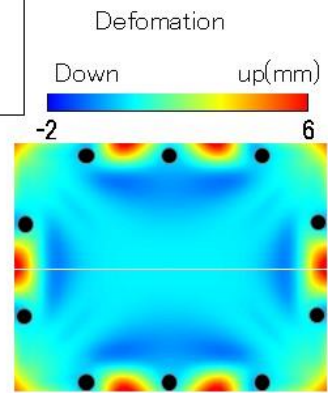
- Sample Size : Steel frame & Aluminum sheet (□500mm × 400mm)
  - Joining : Steel bolt & adhesive
  - Heat treatment : 180°C × 20min
- : Bolt location



【After baking】



【Result of experiment】



【Result of FEM】

⇒ FEM coincide well with the experiment

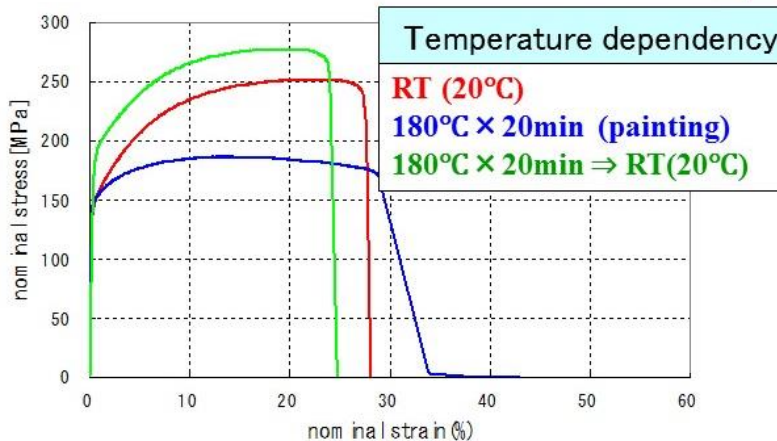
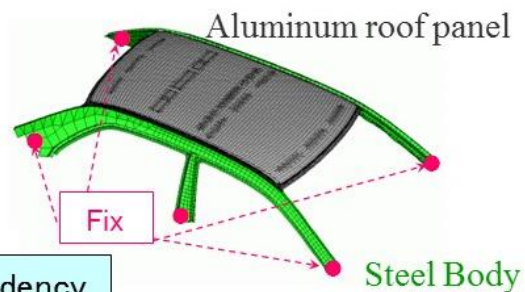
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## 3) Structure design

### ▪ Thermal deformation CAE for Aluminum Roof

#### Heat expansion coefficient

Steel	$1.16 \times 10^{-5}$
Aluminum	$2.30 \times 10^{-5}$

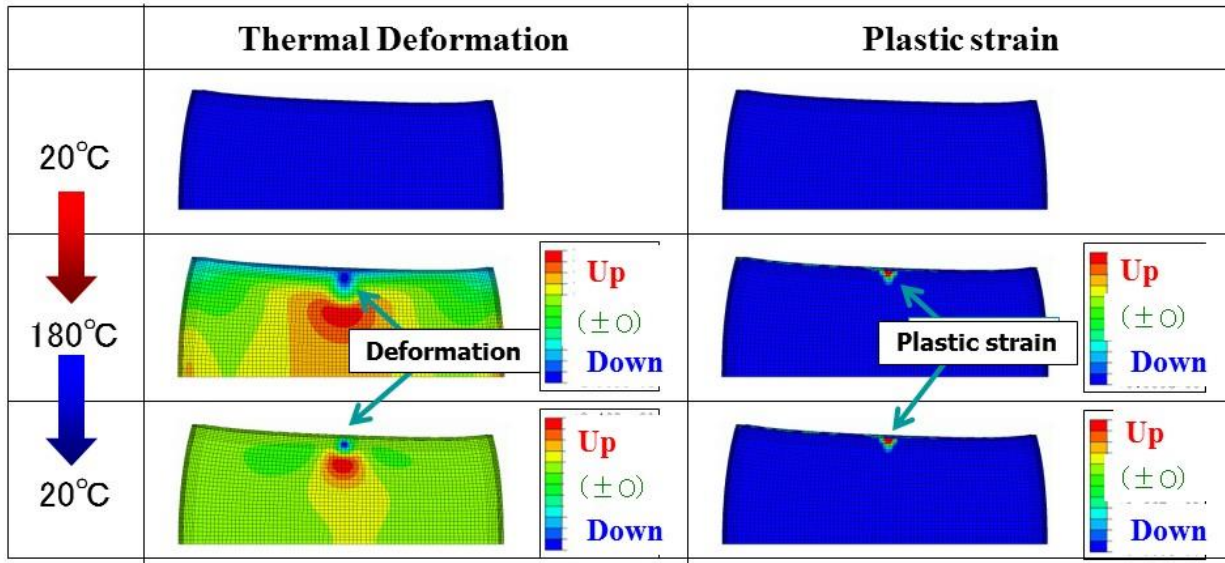


Material : 6K21

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## CAE result of thermal deformation

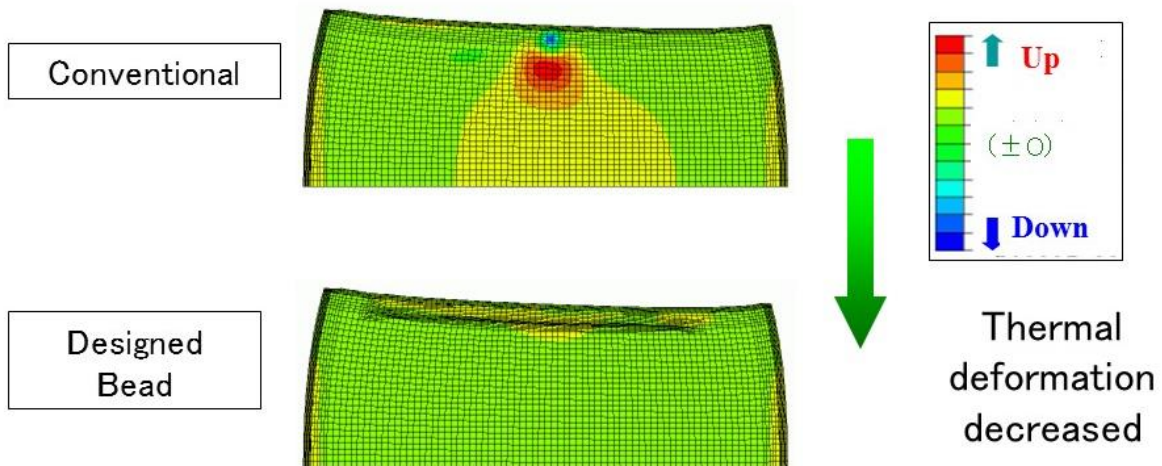
○Material: 6K21-T4 t1.0mm  
 ○Temperature change profile: 20°C⇒180°C⇒20°C



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## Developed Designed Bead Effect



Thermal Deformation (up&down): 6K21-T4 t1.0mm



*Mitsubishi Motors co.*  
*Lancer Evolution (2004)*  
*OUTLANDER (2005)*

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## ● Thermal deformation CAE for Aluminum parts : Al(Outer)-Steel(Inner) Door structure

- Model of Outer /Inner hem joining**

Adhesive      Outer Al 1.0t  
Inner GA Steel 0.6t
- Experiment of thermal deformation**

Outer      Inner  
Hemming

Outlook of joined sample(350x259x1.0mmt)  
Outer Al 1.0t/Inner GA Steel 0.6t)
- Mechanical property change of Al**

nominal stress [MPa]  
nominal strain (%)  
6K21-T4

— 常温状態  
— 高温状態(180℃×20分)  
— 180℃×20分後→常温状態
- Fig. Distribution of thermal deformation after baking**

Experimental result      CAE result

Fig. Distribution of thermal deformation after baking

ΔZ(mm)

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## ● Application for Aluminum(Outer)-Steel(Inner) Door structure

Honda Acura RLX

from Shanghai Motor Show 2015, China

Kobe cooperated thermal deformation CAE

Outer Steel → Al  
Inner (Steel)

本田技研工業株式会社 提供

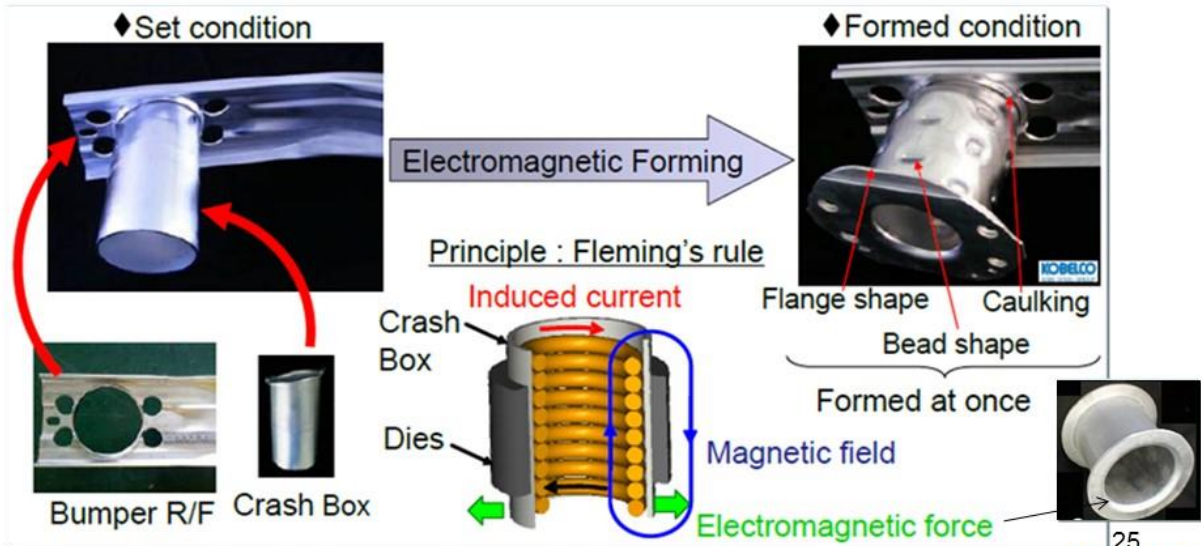


## 4) Forming & Joining

### ● Electromagnetic forming technology

For a demand of the three-dimensional processing of aluminium extrusion, we developed electromagnetically forming technology with high productivity.

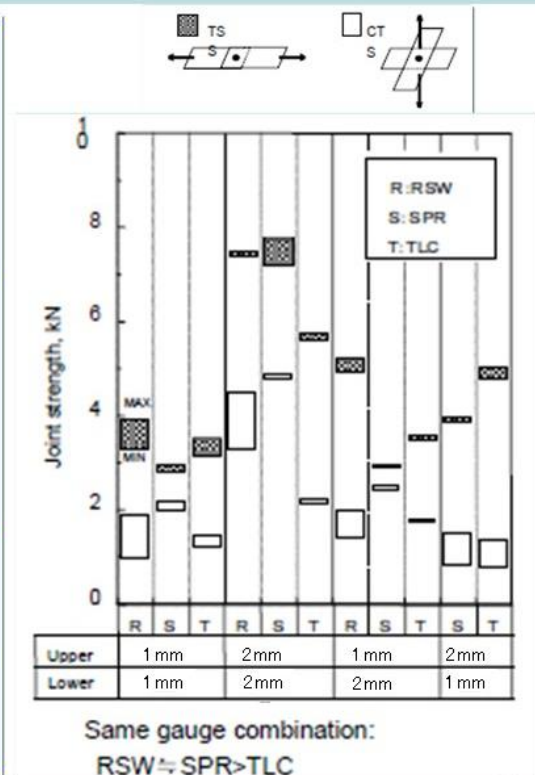
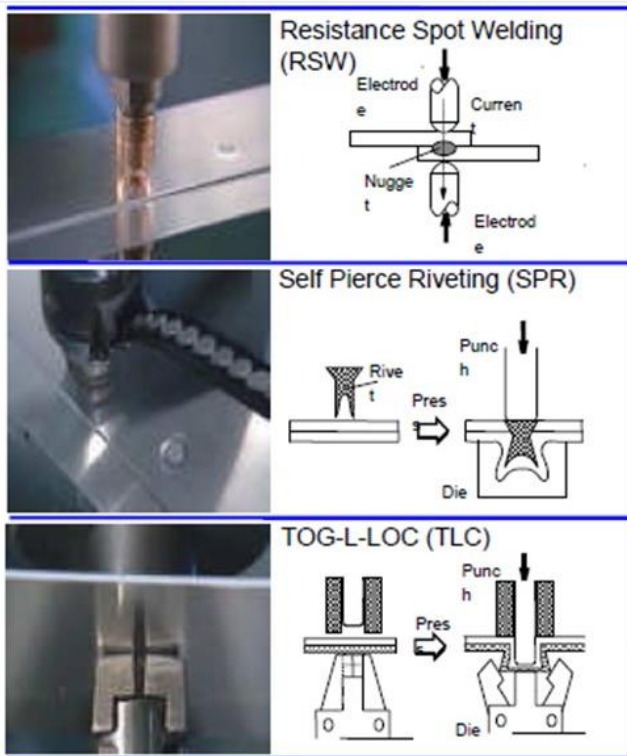
- Suitable for high conductivity materials, such as aluminium.
- Processing time is less than 20 $\mu$ s.



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## 4) Forming & Joining



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## ● Newly developed mechanical joining

### : Piercing Metal Joining

<p>Piercing &amp; Joining of Piercing Metal</p>	<p>Resistance Spot Welding Process</p>	
---	--	--

**Developed piercing metal joining**

Piercing Metal (Steel)  
Al 1.0mmt  
Steel 0.8mmt

Cross-section sketch of Piercing Metal Joining

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## ● Technology of Aluminum & PP-resin direct joining by injection molding

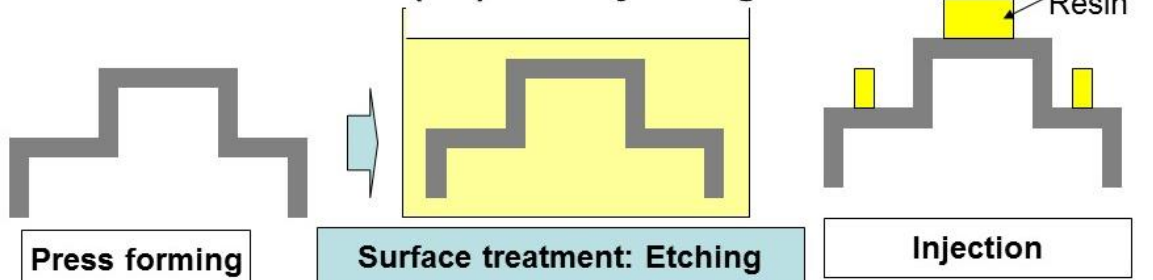
### 1. Conventional Metal- (PP)Resin joining

⇒ PP resin Inner & Steel RF is joined with steel bolt



Steel RF

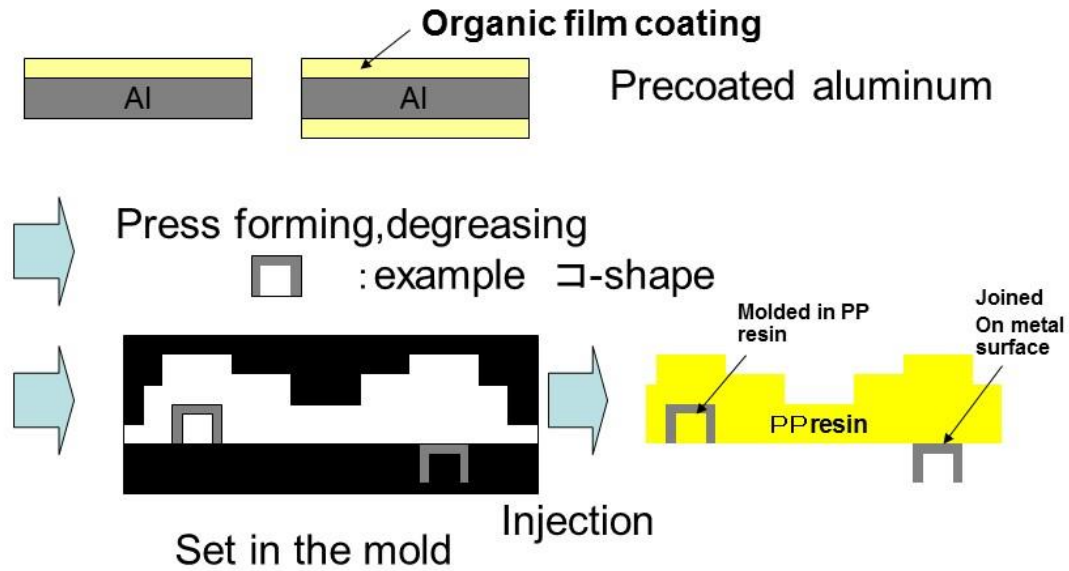
### 2. Conventional Metal- (PP)Resin joining



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## ● Kobe's proposal



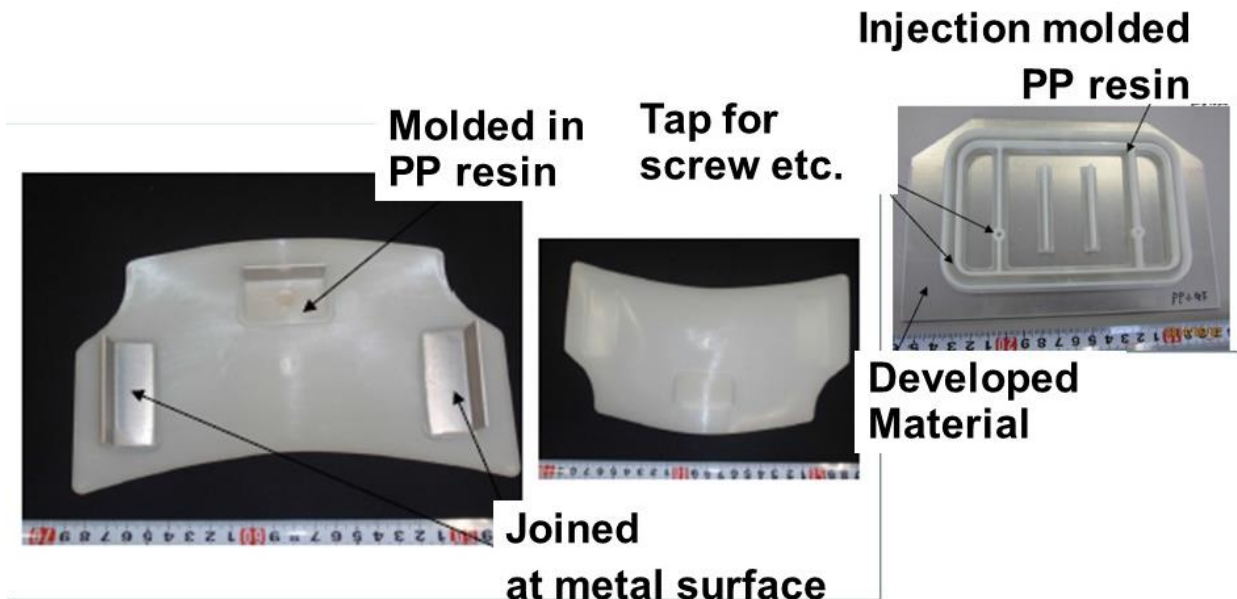
⇒ Useful solution for PP resin-Aluminum multi-material structure

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## ● Aluminum & PP-resin

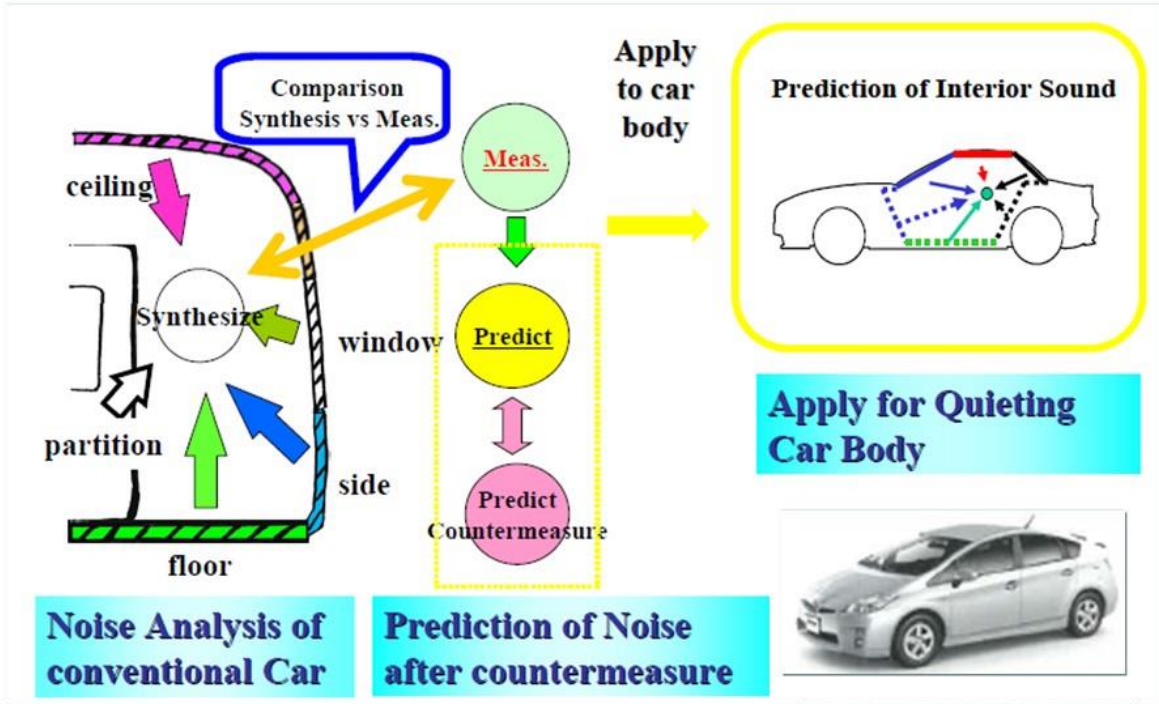
directly joined samples



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## 5) Solution for NV problem caused by Lightweighting



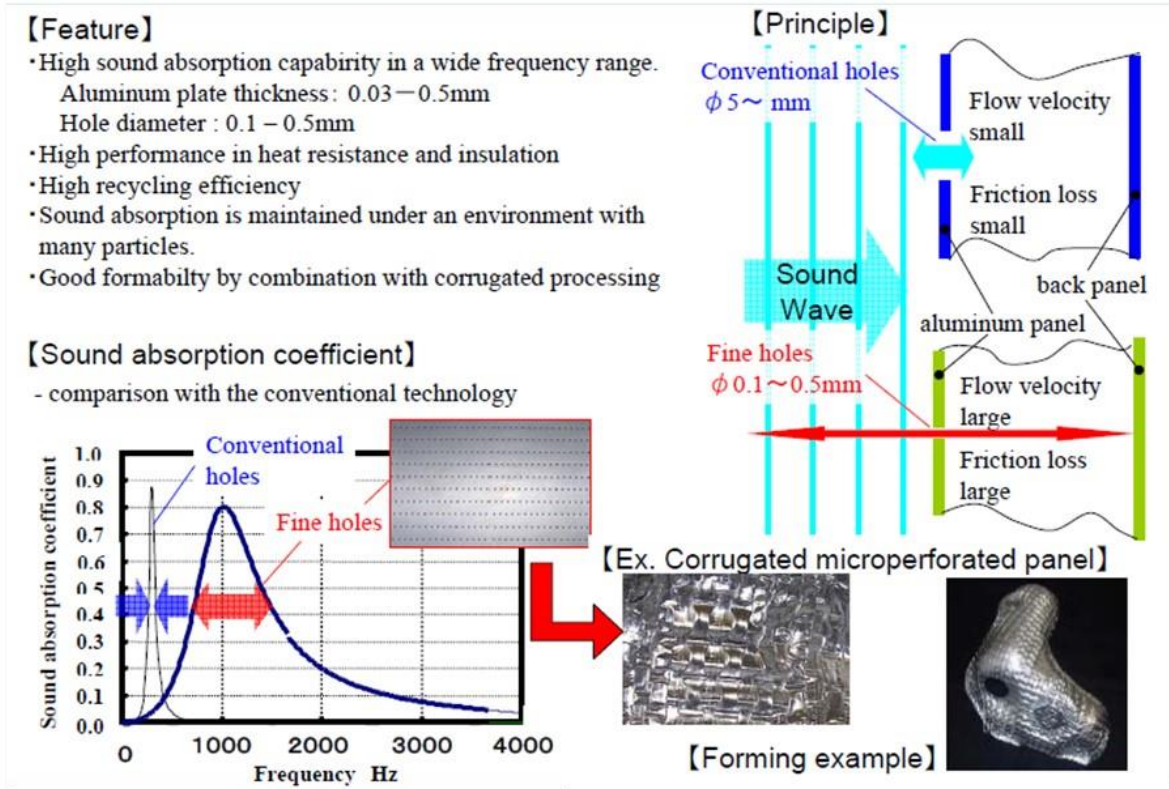
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## Testing Facilities



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## ● Absorbing Aluminum Micropurforated Panel



made by Sanwa Packing Industry, Osaka, Japan

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## Contents

### ◆ KOBE STEEL company overview

Introduction of Kobe Steel.

### ◆ R&D topics

#### 1) Research and Development Strategy

#### 2) Material

- Newly developed 6xxx alloy with high paint bake response

#### 3) Structure design

- Pedestrian protection aluminum hood development
- Thermal deformation CAE for Aluminum parts

#### 4) Forming & Joining

- Electromagnetic forming technology for Bumper system
- Newly developed mechanical joining
- Technology of Aluminum & PP-resin direct injection joining

#### 5) Solution for NV problem by Lightweighting

### ◆ Global foot print

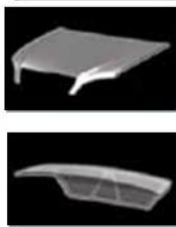
Flat rolled, Forged, Extruded products supply scheme  
in Japan, China, US, Europe

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## Global footprint of Kobe Steel, aluminium

Products	Japan	US	China	Europe
Flat rolled	● Tochigi	(●) TBD	● Tianjin 2016-	□ Technical cooperation with Hydro
Forged	● Mie	● KY	● Suzhou	● Under consideration
Extruded	● Yamaguchi	● KY (Materials: SAPA, Fabrication: KOBE)	● TBD	● TBD



Flat rolled products for BIW.



Forged suspension parts.



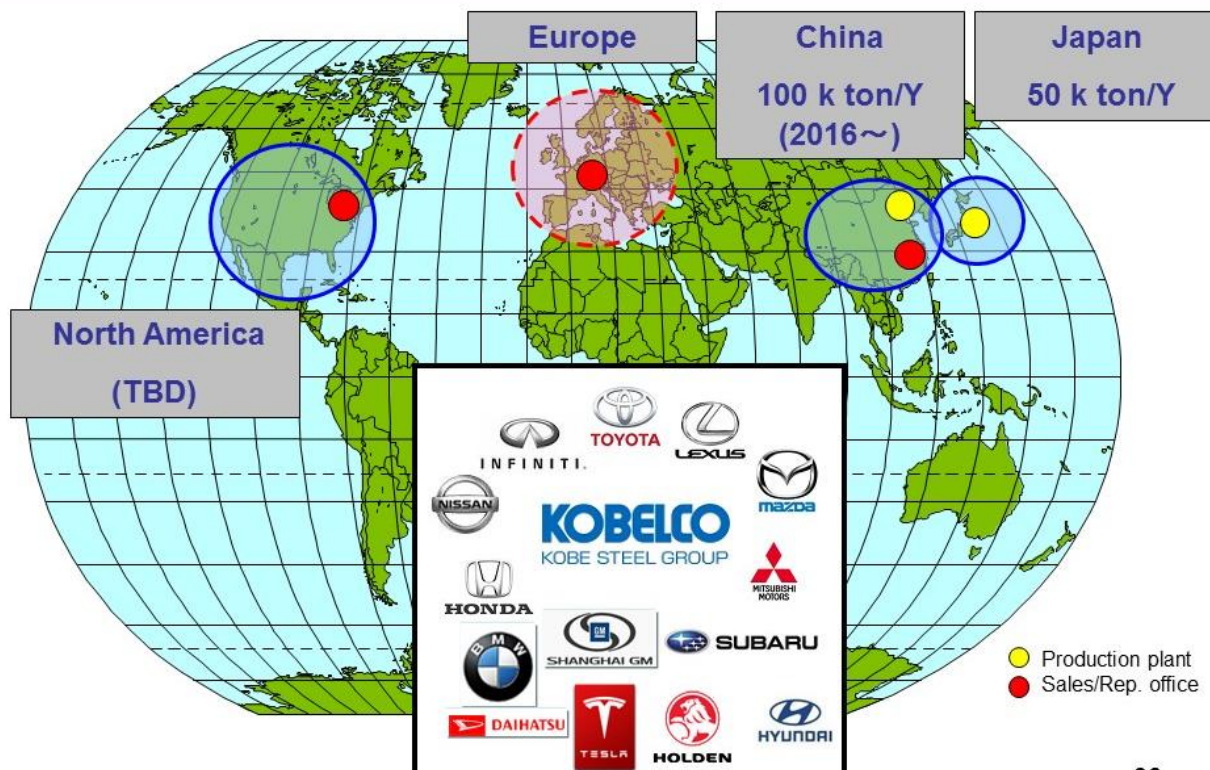
Extruded bumper system.



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## Aluminium Flat Rolled Products



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## New plant in China

Production capacity will be 100,000 M ton/year, from 2016.



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## Summary

- Kobe Steel have a potential to support the lightweighting activities for OEM's globally.
- To improve required performance of the car, Kobe Steel is working continuously with our customers.
- To achieve the lightweighting BIW with aluminium, Kobe Steel is proceeding the application technology development, such as Forming, Joining and Product design with thermal distortion and/or crush behavior control.

**See you at Kobe Steel booth during Aluminum China 2015 !!**

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**Thank you for your attention.**

**See you at Kobe Steel booth  
during Aluminium China 2015 !!**





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**<http://www.gasgoo.com>**

## **TITLE**

The Status and Development Trends of China Automobile Lightweight

## **ABSTRACT**

The major vehicle manufacturers in the lightweight field in Chinese market are divided into 2 parts: domestic manufacturers and foreign manufacturers. The domestic manufacturers focus on technological advantages and key performance, while foreign manufacturers emphasis on the localization in china. A brief introduction of the main lightweight technologies in china; The comparison of various lightweight technologies as well as their development stages in china; The comparison of the application of the lightweight technology between domestic and foreign manufacturers; China's shortages and potential compared with foreign countries; The prospects of China lightweight technology in the future.

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## TITLE

TOP 16 GLOBAL RANKING OF ALUMINIUM AND MAGNESIUM FOUNDRIES BY REVENUE

## ABSTRACT

Top 16 global ranking of aluminium and magnesium foundries

- Ranking by Revenue
- Plant overview: Number of plants by region & inhouse processes
- Group plants locations & processes
- Customer location map
- Summary

15 Leading Magnesium Foundries

- Plant overview: Clamping force range & inhouse capabilities
- Magnesium HPDC automotive product samples

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Market Research

- Tailored Customer Databases about Foundries, Tool Makers, Extrusion Consumers, ...
- Automotive Application, Material & Process Analyses
- Industrial Application Research
- Lightweight Technology Outlook in Aluminum, Carbon, Composites & Magnesium



Market Development

- Analysis & Development of Market Opportunities
- Accelerate Market Penetration
- Manage New Product Launches
- Establish a Sales Force
- Sales on Demand
- Access & Build-up new Markets



Roadshows / Events

- Organization of Technical & Commercial Roadshows
- Oversea Commercial & Technical Events
- Host In-House Events & Presentation
- Common Technology Booth at Leading Exhibitions



Strategic Localization

- Warehousing & Distribution Service
- Supplier & Tie-up Localization
- Identification & Trade-off of new Technology
- Foreign Market Business Cases and whose Realization

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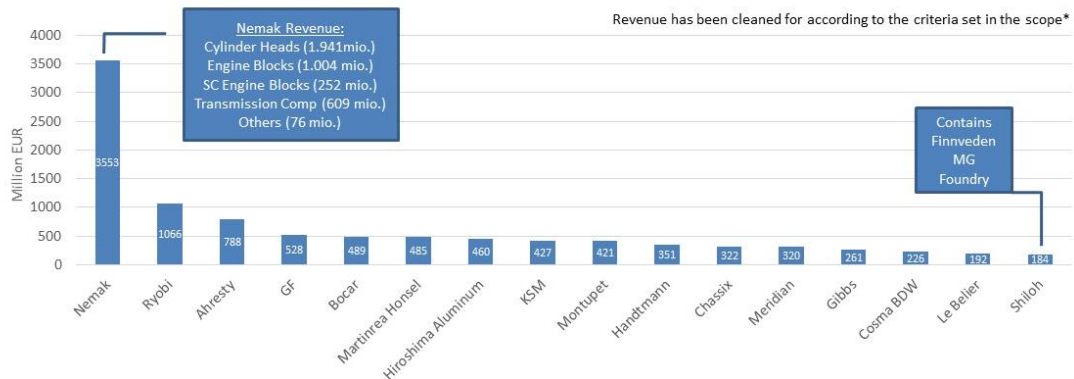
#### SCOPE

## TOP 16 GLOBAL RANKING OF ALUMINIUM AND MAGNESIUM FOUNDRIES BY REVENUE

### NON EXCLUSIVE CLIENT RESEARCH CONDITIONS

1. Exclude OEM Foundries
2. Consider Only Automotive Revenue Generated By Producing BIW, Chassis (Excluding Rims) And Powertrain Applications
3. Exclude HD Trucks & Busses
4. Exclude Sand Cast Applications [But incl. NEMAK LPSC]

#### TOP 16 ALUMINIUM & MAGNESIUM FOUNDRIES WORLDWIDE (REVENUE 2013)



Note: OEM facilities and those from system suppliers like Aisin, Denso, ZF, .... does not have been considered

#### PLANT OVERVIEW – TOP 16 ALUMINIUM & MAGNESIUM FOUNDRIES WORLDWIDE

GROUP	PROCESSES INHOUSE	CNC	NAFTA*	ASIA*	EURO*	SA*
Nemak	HPDC - LPDC - GDC - Rotacast - SC - Tilt - Cosworth	Yes	8	3	9	2
Ryobi Global	HPDC - LPDC - GDC - RNC	Yes	2	8	1	0
Ahresty	HPDC - GDC	Yes	2	7	0	0
GF	HPDC	Yes	0	1	3	0
Bocar/Auma	HPDC - GDC	Yes	5	0	0	0
M. Honsel	SC - LPDC - HPDC - PMC	Yes	1	1	2	1
HAI	HPDC - GDC - SC - Squeeze	Yes	1	7	0	0
KSM	HPDC - PMC - CPC - CVC	Yes	1	2	5	0
Montupet	LPDC - Tilt gravity	Yes	1	1	5	0
Handtmann	HPDC - GDC - Lost foam	Yes	0	1	3	0
Chassix	CPC - LPDC - GDC - SC - PMC - Squeeze	Yes	4	1	0	0
Meridian	HPDC	Yes	4	1	1	0
Gibbs	HPDC	Yes	1	1	1	1
Cosma BDW	LPDC	Yes	2	2	4	0
Le Belier	GDC - SC - Rheocasting - HPDC - LPDC	Yes	1	3	3	0
Shiloh	HPDC, Squeeze	Yes	5	(1)	1	0

↑ New plant to open in mid-2016

\* Only MG & AL foundries have been listed. More plants at same address only count as one.  
 SA = South America

#### EXTRACTION OF THE PLANT LIST – TOP 16 ALUMINIUM & MAGNESIUM FOUNDRIES WORLDWIDE

GROUP	CITY	STATE	COUNTRY	TRIAD	PROCESSES
Handtmann	Biberach	B. Württemberg	Germany	EURO	HPDC - GDC - Lost foam
Handtmann	Annaberg-Buchholz	Sachsen	Germany	EURO	HPDC
Handtmann	Košice	Košice	Slovakia	EURO	HPDC
Handtmann	Tianjin	MI	China	ASIA	HPDC
Chassix	Benton Harbor	MI	USA	NAFTA	CPC
Chassix	Bristol	IN	USA	NAFTA	LPDC - GDC
Chassix	Montague	MI	USA	NAFTA	PMC
Chassix	Stevensville	MI	USA	NAFTA	CPC
Chassix	Suzhou	Jiangsu	China	ASIA	PMC
Meridian	Strathroy (Plant I)	ON	Canada	NAFTA	HPDC
Meridian	Strathroy (Plant II)	ON	Canada	NAFTA	HPDC
Meridian	Eaton Rapids	MI	USA	NAFTA	HPDC
Meridian	Sutton-in-Ashfield	Nottinghamshire	UK	EURO	HPDC
Meridian	Anting Town Jiading	Shanghai	China	ASIA	HPDC
Meridian	Ramos Arizpe	Coahuila	Mexico	NAFTA	HPDC

\* Only MG & AL foundries have been listed.  
SA = South America

#### SUMMARY

1. Nematik is the biggest player on the market followed by Ryobi, Ahresty & GF
2. All four groups above have in common that a large piece of the revenue is made producing engine blocks and cylinder heads
3. Shiloh with the acquisitions of Albany, Contech and Finnveden is expected to move up in the top 16 revenue list in a short; max mid term outlook
4. The same can be said for Cosma Cast Division with new plant investments in USA and China. Cosma will triple its production of BIW and chassis applications within the next few years
5. Chinese foundries have not made it into the top 16 with Guangdong Hongtu and Yujiang Die-Casting on the 18th and 19th position
6. The NAFTA procurement co-operation for HPDC Aluminium between BMW and Daimler does significant signals the lightweight pressure the OEM and system suppliers does have
7. OEM enlarging their engagement in aluminium casting facilities or jumping in, like Audi

#### SCOPE

## LIST 15 LEADING MAGNESIUM FOUNDRIES

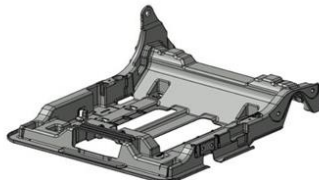
### CLIENT CONDITIONS

1. Consider MG Foundries Active Within Automotive BIW/ Structure & Interior Applications
2. Thixo Casting / Molding Was Not A Focus
3. Process Focus Was HPDC

#### MERIDIAN [KEY PLAYER] PRODUCT SAMPLES



GM Corvette C7 MG Seat Back Frame



Ford Explorer / Ford Flex D4 MG Seat Structure



Lincoln MKT D4 Rear MG Tailgate



BMW X3 PL4 MG Cross Car Beam



Dodge Viper MG Firewall



Tesla Model S MG Front End Carrier

Source: Meridian

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**THE MARKET DEVELOPER**

### ASIA AUTOMOTIVE LIGHTWEIGHT PROCUREMENT SYMPOSIUM - SHANGHAI 2015 JULY 6th TO 8th

#### MAGNESIUM FOUNDRY LIST – SUPPLIERS OF AUTOMOTIVE INTERIOR APPLICATIONS

GROUP	CITY	STATE	COUNTRY	FROM C. FORCE (T)	TO C. FORCE (T)	Number Of HPDC Cells	CNC	TOOL SHOP
Auer Metallkomp.	Amberg	Bayern	Germany	160	1.650		Yes	No
Brabant	Verres	Aosta Valley	Italy	400	2500	11	Yes	No
Brabant	AN Oss	Nordbrabant	Netherlands	700	3200	25	Yes	No
DGS	Guangzhou	Guangdong	South China	850	1.650	10	Yes	Yes
DGS	St. Gallen	St. Gallen	Switzerland	20	3.200	32	Yes	No
FAW	Changchun	Jilin	Northeast China	150	2.700	19	Yes	Yes
Georg Fischer	Altenmarkt	St. Gallen	Austria	550	3.300	24	Yes	
Georg Fischer	Suzhou	Jiangsu	Southeast China			15	Yes	No
Gibbs	Henderson	KY	USA	650	1.600	25	Yes	Yes
Gibbs	Dalian	Liaoning	Northeast China	850	1.200	7	Yes	Yes
Gibbs	Retsag	Nógrád	Hungary	850	1.200	5	Yes	Yes
Gibbs	Contagem	Minas Gerais	Brazil	630	1.200	7	Yes	Yes
Grupo Antolin	Valdorros	Burgos	Spain		1.850	5	Yes	No
Laukötter	Dessau	Sachsen-Anhalt	Germany	100	3.500		Yes	Yes
Mercedes	Esslingen-M.	Baden-Würt.	Germany		4.200		Yes	

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AUTOMOTIVE LIGHTWEIGHT  
**PROCUREMENT SYMPOSIUM**  
Westin Hotel in Detroit, USA



**AluMag®**  
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Light Weighting - Emission Reduction - Car Comfort  
Technology Center, Booth # 763 - Detroit - Cobo Center, MI USA



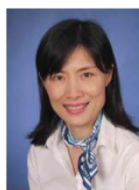
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**Europe 2016** 27<sup>th</sup> - 29<sup>th</sup> of Nov  
AUTOMOTIVE LIGHTWEIGHT  
**PROCUREMENT SYMPOSIUM**  
Hilton Hotel in Duesseldorf, Germany



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