Lightweighting Technologies
New materials grades

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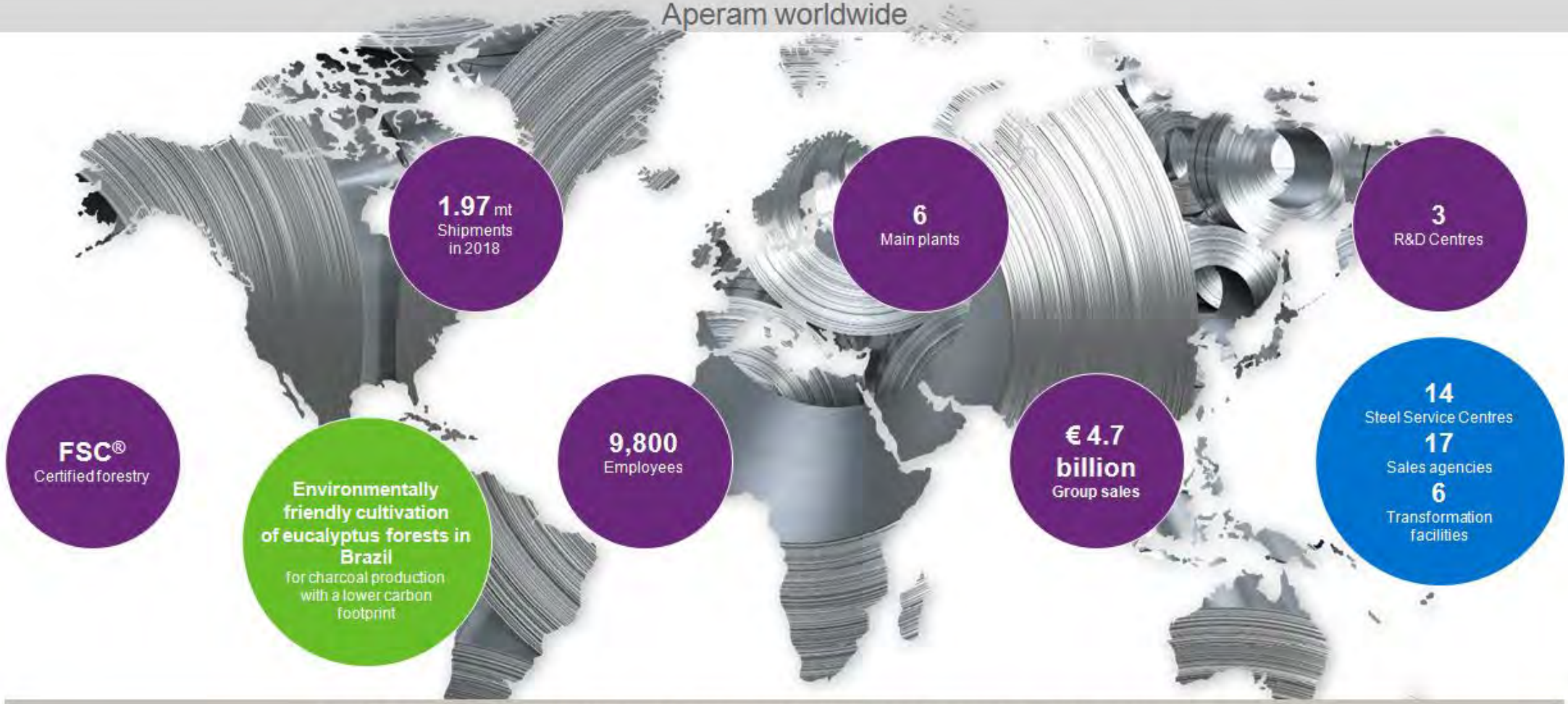
Charting New Roads
to Cost and Weight Reduction

Body in MaX

1. Motivation & Project Strategy
2. Defining Performance Targets: NVH & Crash
3. Current Market Reference: Establishing the Baseline
4. The MaX Optimised Solution: BIW Lightweighting with MaX Grades
5. Feasability
6. Cost Analysis
7. Partners

Motivation & Project Strategy

Aperam worldwide



A leading and geographically well-positioned stainless and specialty steel producer with a highly integrated sales, distribution and steel services network

The Innovation Strategy From Concept to Creation:

Aperam's Product Development Strategy

MaX BY aperam

Partnership

- **Altair:** crash and NVH simulations, structural optimisation
- **Bertrandt Engineering:** costing
- **Conex:** prototypes and feasibility
- **Schuler:** feasibility and real industrial trials
- **Oerlikon:** feasibility analysis
- **Magnetto Automotive:** real industrial trials

#Customers = 2

2016

1 **Be Known** — Communication plan

- Identify key industry events: Automotive Circle + SAE Brazil
- Communication kit: brochure, video, exhibition parts...
- Submit abstract and papers to trade publications

2 **Add Value** — Product best definition

2017

- Feasibility guidelines: stamping
- Define best processes for this new family of grades e.g. painting, oxidation, welding
- Costing
- Define targeted parts

3 **Be Present** — Strong customer approach

- Promote to potential customers via technical workshops: all OEMs, TIER1s, TIER2s

2018

4 **Be Real** — From concept to reality

- Industrial trials
- Partnerships
- Customer projects
- Prototyping

5 **Be Assertive** — Qualification by customer

- Sampling
- Follow up customer development and qualification plans

6 **Optimize** — Co-Design

- Body-in-White specific reviews
- Body in MaX
- Business Cases

Body in MaX

2019

7 **Launch Business** — 1st Orders

- Portfolio of applications

#Customers = 23

Baseline
19 Parts - 40.1 kg

MaX
3 Parts - 34.6 kg

-14 %
weight reduction
reduction in thickness and the number of parts required

Charting New Roads to Cost and Weight Reduction

Grades	YS (MPa)	UTS (MPa)	EL (%) ISO A80	V-Bending (°)	Fracture strain	Fatigue (MPa) R-1	Welding (RSW)	PREN	KCV@-40°C (J/cm²)**	KCV@20°C (J/cm²)**
22MnB5	1020	1450	5	55	0.3	475	Reference	N/A	60	75
MaX1.2HY	870	1130	8	100	0.76	590	Equivalent as 22MnB5	11	75	80
MaX1.6	1100	1600	7	70*	0.4*	800*	Equivalent as 22MnB5	12	35	50
MaX HSHE	800*	1300*	20*	80*	0.45*	650*	Equivalent as 22MnB5	17*	80*	95*

Typical values
* Values to be confirmed
** For 1.5 mm thickness

MaX, Aperam's new family of AHSS grades, is available in three grades: MaX1.2HY, MaX1.6 and MaX HSHE (High Strength High Elongation). MaX1.2HY and MaX1.6 are currently being tested by our partners and customers, while MaX HSHE will be available for trials starting in 2019.

MaX1.6 and MaX1.2HY are ferritic stainless steels that, after thermal treatment, achieve a martensite phase, thus giving them an extremely high strength (until 1 600 MPa).

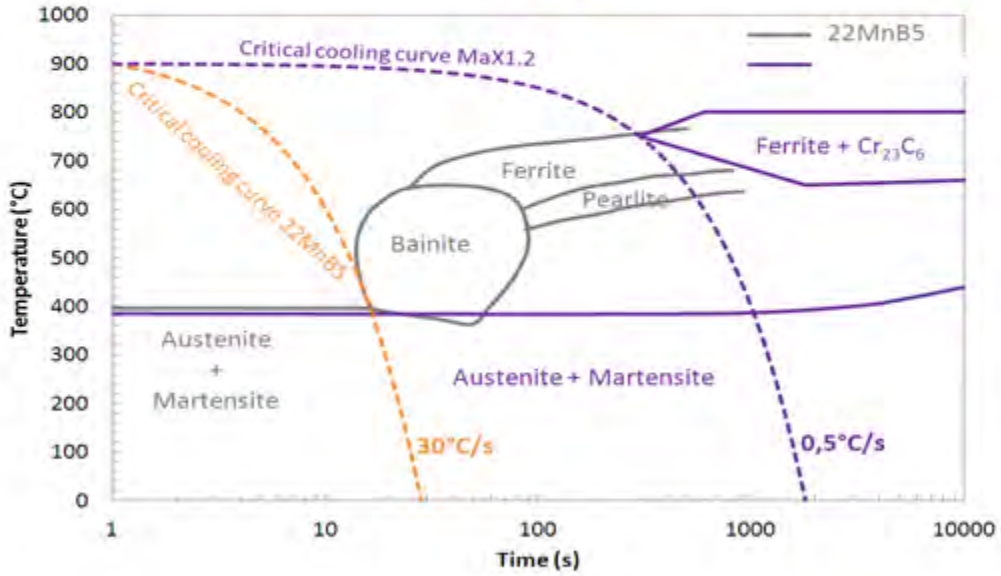
Customers are already testing and qualifying this cost-effective material for reducing the weight of targeted parts.

MaX1.2HY vs. 22MnB5

MaX1.2HY CCT (Continuous Cooling Transformation) diagram determination - Dilatometry performed using the Gleeble 3500

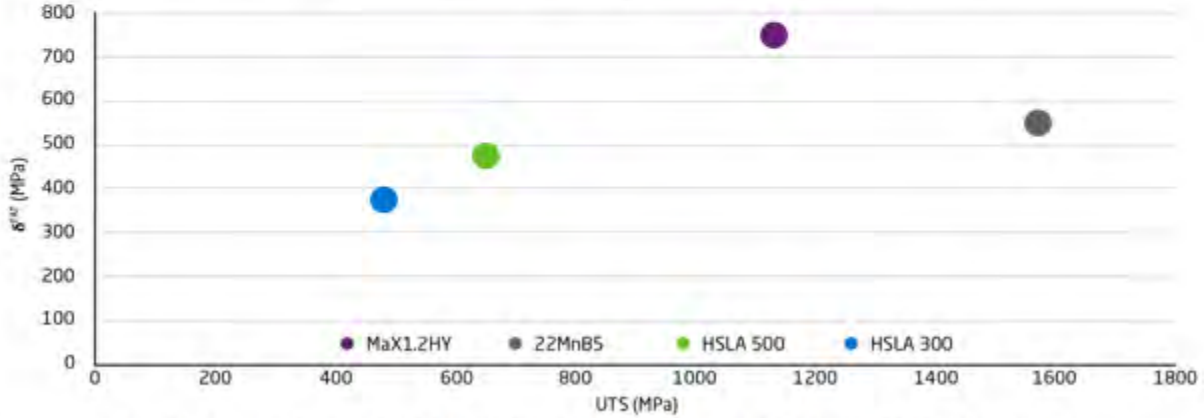
No critical cooling rate MaX 1.2HY: 0.5°C/s (MaX 1.6: 0,1°C/s)

Critical cooling rate 22MnB5: 30°C/s



Fatigue properties of quenched MaX1.2HY - 50% higher than 22MnB5

			Four point alternative bending — R = -1			
Material	Edge	UTS (MPa)	^{FAT} (MPa) 10^5 cycles	^{FAT} (MPa) $2{\cdot}10^6$ cycles	^{FAT}/UTS $2{\cdot}10^6$ cycles	k_t (^{FAT}G2/^{FAT}G1)
MaX1.2HY	G1	1130	756	605 ± 17	0.54	0.91
	G2		714	568 ± 16	0.5	
22MnB5	G1	1569	686	535 ± 21	0.34	0.62
	G2		516	330 ± 36	0.21	

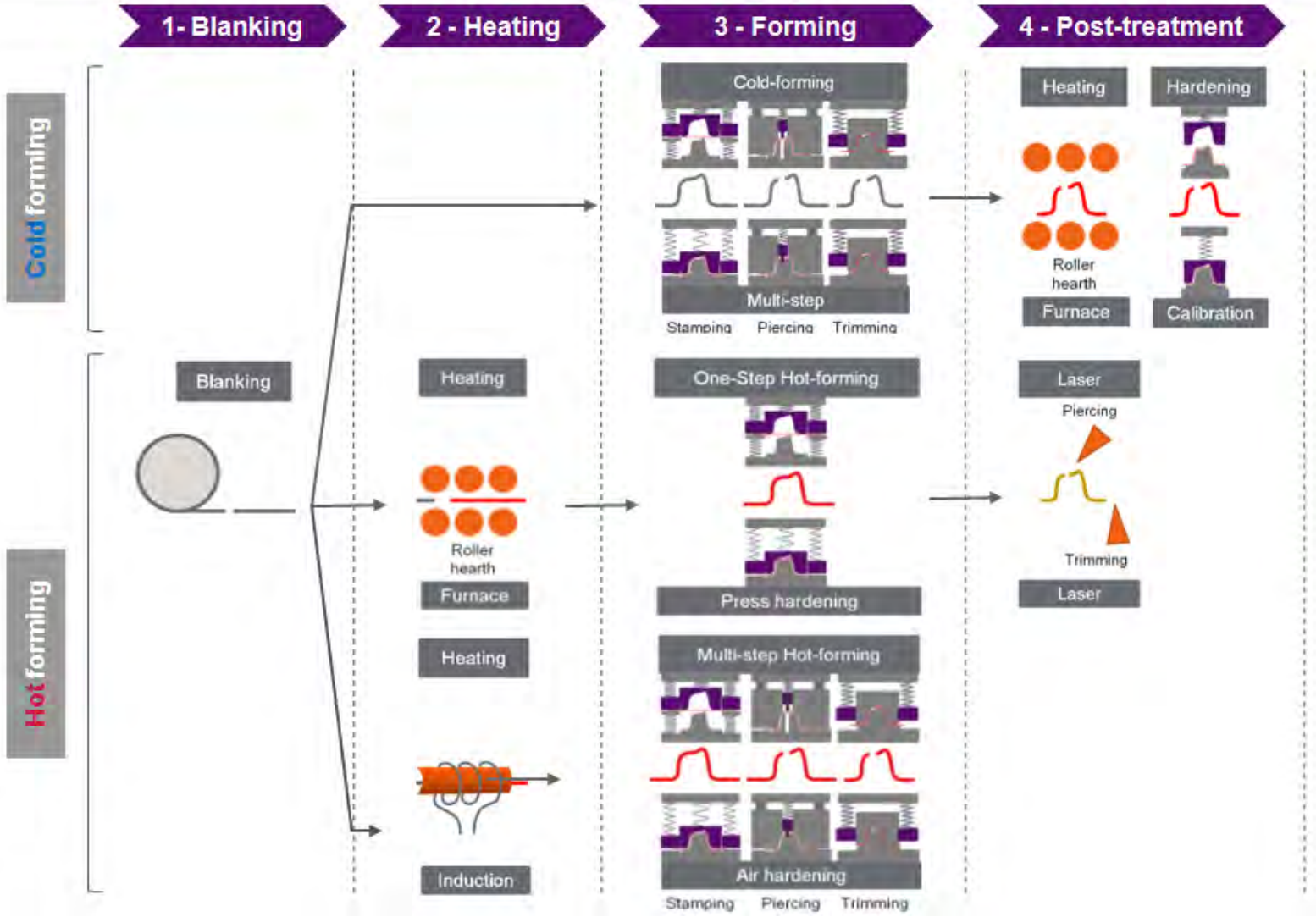


Casellas & al. - New Stainless Steels for Press Hardening with improved Fatigue Behavior - CHS2 conference 2019

Stainless steel Martensitic grades are perfectly adapted to additive manufacturing due to their low sensitivity to the cooling rate.

Motivation & Project Strategy

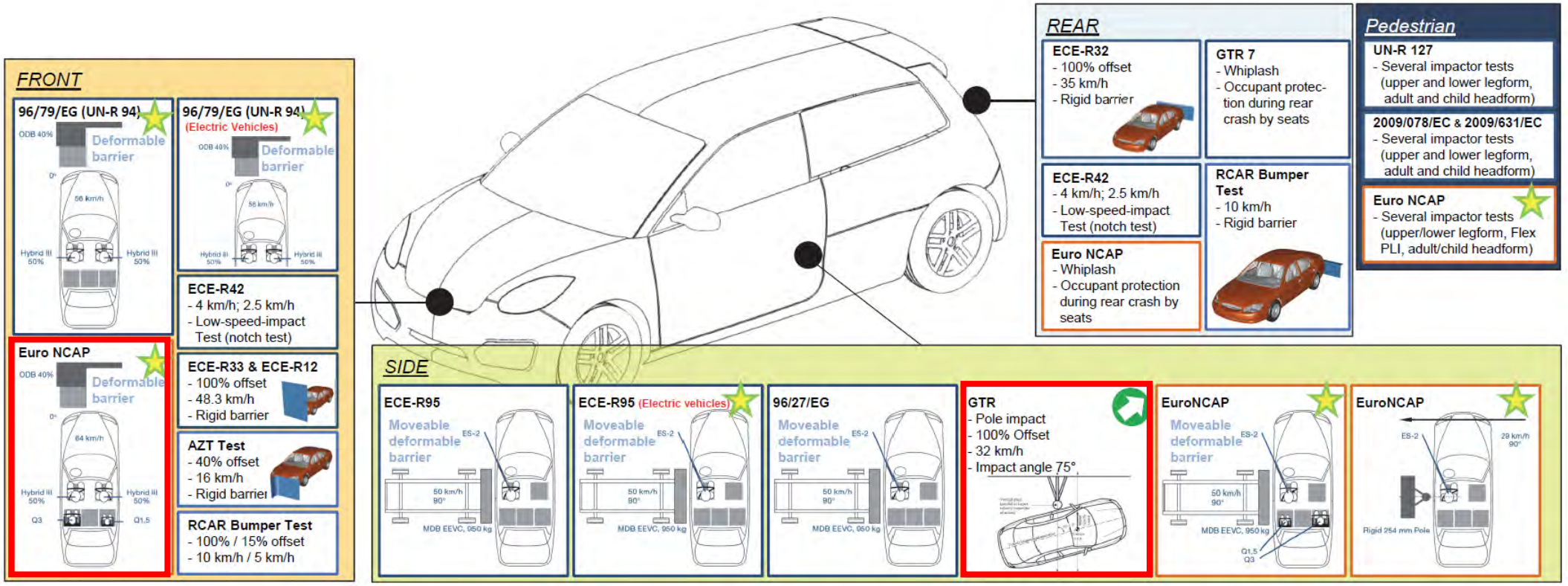
Hot or Cold forming operations



MaX grades are perfectly adapted to any forming operation, either cold or hot!

Defining Performance Targets: NVH & Crash

Overview of EU Load Cases



Current Market Reference: Establishing the Baseline

DONOR MODEL		BASELINE MODEL		MaX SOLUTION
	WP1 →		WP2 →	
Public model 2008 performance level		Current market requirements -> grade and geometric updates		Lightweight design with Aperam MaX Grades

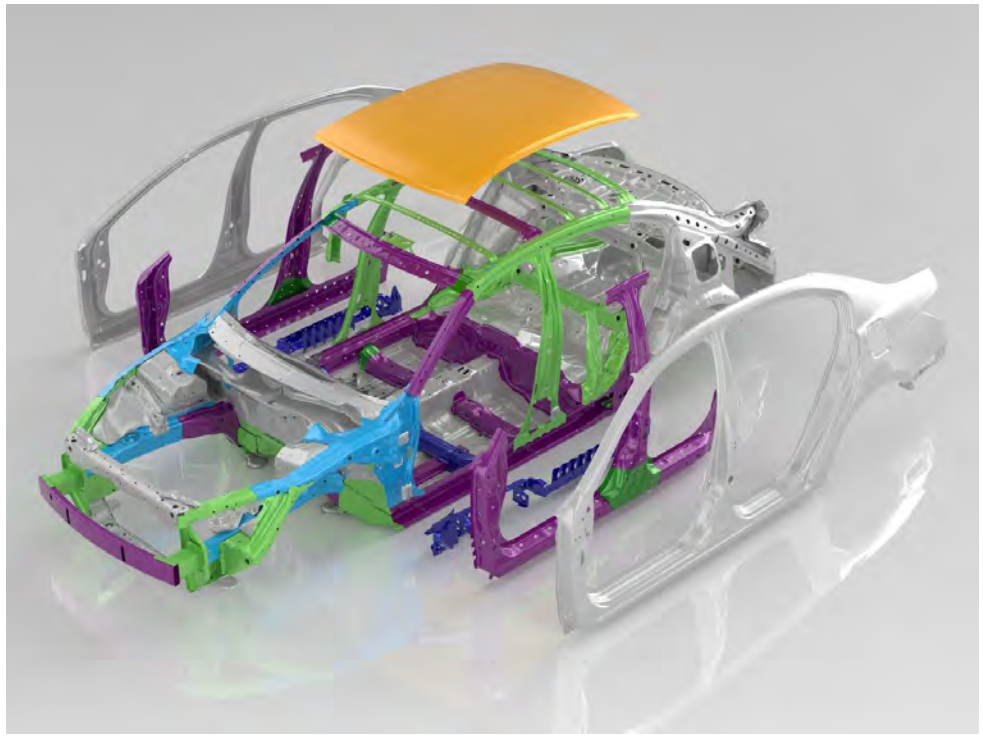
Target Setting and Benchmarking

- **Goals**
  - Selection of load cases and definition of structural targets in terms of NVH and crash performance
- **Main Steps**
  - Benchmark NVH performance of current market and recent C-/D-segment cars
  - Discuss how to define meaningful structural crash targets with passive safety experts
  - Target setting: define structural targets for all NVH and crash load cases

Establishing the Baseline: Material Update

Modifying the steel grades to adapt the material to current market practices:

- Ultra high strength steel for safety cell
- High energy absorbing steel for crash zones
- Geometry modifications



Ultimate Tensile Stress (MPa)

1500	Usibor 1500 / MS 1500
1400	
1300	
1200	
1100	
1000	DP 1000
900	
800	DP 800
700	
600	Ductibor / DP 600
500	DP 500
400	

Status: NVH Global (Analysis performed at BiW level)

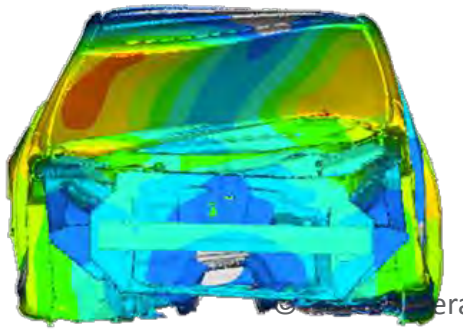
Setup			Results			
Domain	Performance	Unit	DONOR Model	BASELINE Final	Absolute Difference	Relative Diff (%)
Modal	Torsion	Hz	46	50	4.00E+00	9%
	First Order Bending	Hz	42	43	9.10E-01	2%
	Second Order Bending	Hz	36	37	7.10E-01	2%
	Front End Lateral Bending	Hz	32	34	1.06E+00	3%
Static	Torsion	kNm/°	18.0	22.0	3.99E+00	22%
	Bending	kN/mm	12.1	15.9	3.83E+00	32%
Mass	BIW + Glasses + IP beam + NSM	kg	410.4	407.5	-2.81E+00	-1%

FRONT END LATERAL MODE
BSL_NVH55c_OPT2a_Mod1.h3d
Mode 7 - F = 33.5 Hz

SECOND ORDER BENDING MODE
BSL_NVH55c_OPT2a_Mod1.h3d
Mode 8 - F = 36.9 Hz

FIRST ORDER BENDING MODE
BSL_NVH55c_OPT2a_Mod1.h3d
Mode 9 - F = 42.6 Hz

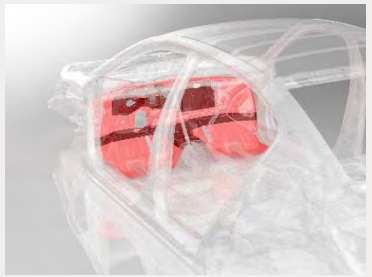
TORSION MODE
BSL_NVH55c_OPT2a_Mod1.h3d
Mode 11 - F = 50.0 Hz



The MaX Optimised Solution: BiW Lightweighting with MaX Grades

The Max Optimised Solution: Final MaX Status

Overview

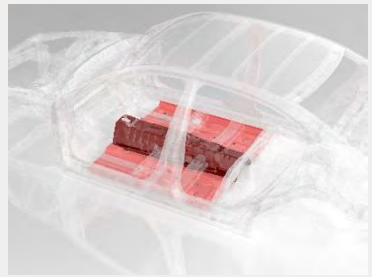


Dashboard

Patch

Overlap Patchwork Blanks

> **-9 %** weight reduction



Front Floor

Taylor Welded Blank

Tailor Welded Blanks

> **-14 %** weight reduction

Rear Floor

Taylor Welded Blank

Tailor Welded Blanks

> **-18 %** weight reduction

-14 %
weight reduction

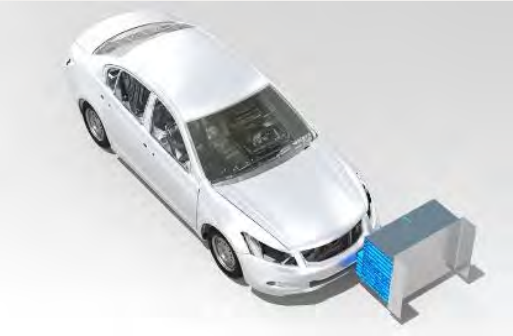
+0 %
equivalent cost

-25 %
manufacturing steps

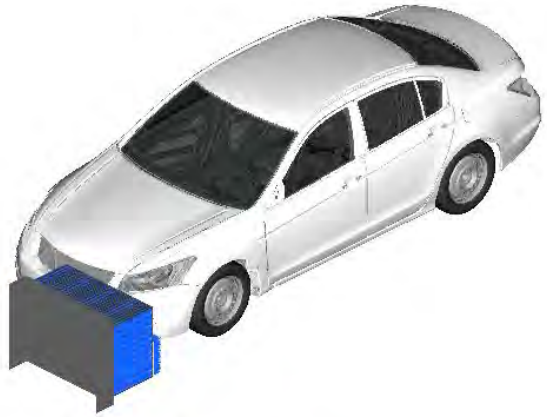
-75 %
Investment

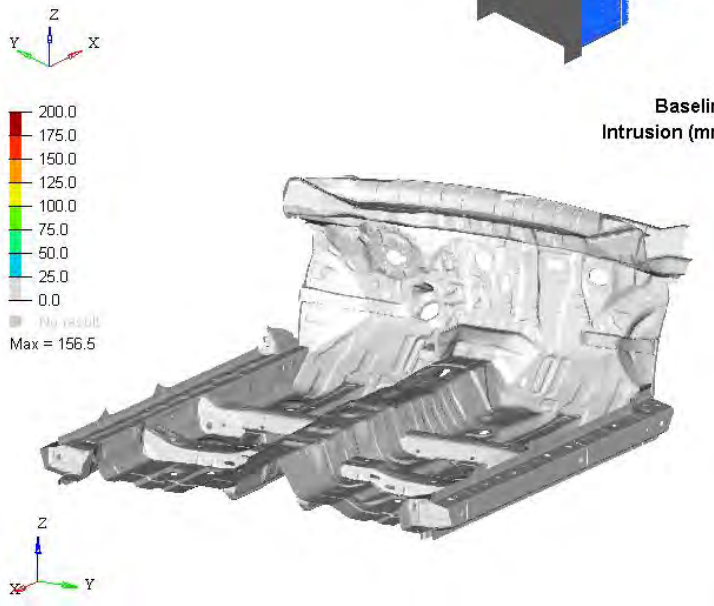
FRONT ODB

Status: Front ODB

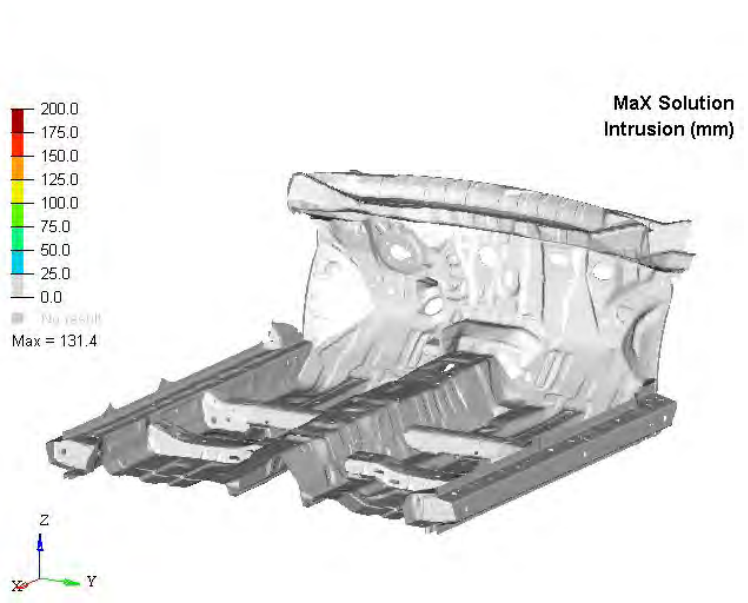


- Velocity: 64 km/h
- Offset: 40 %





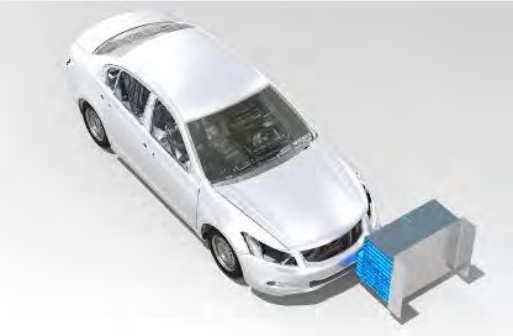
Baseline



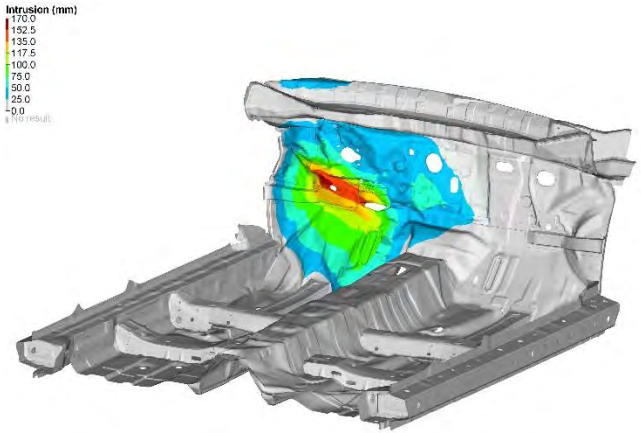
MaX Solution

The Max Optimised Solution: Final MaX Status

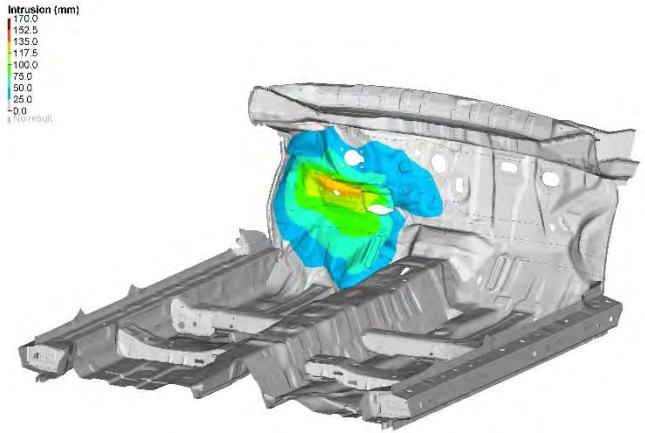
Status: Front ODB



> Velocity: 64 km/h
> Offset: 40 %



Baseline



MaX Solution

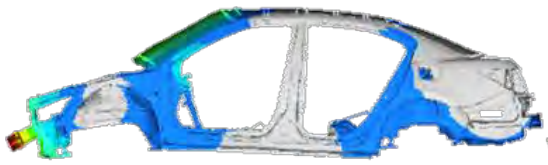
> As illustrated above, the MaX Dashboard preserves the safety cage during an ODB front crash

Status: NVH Global (Analysis performed at BiW level)

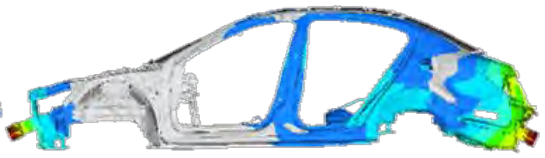
Setup			Results			
Domain	Performance	Unit	BASELINE Final	MaX Solution	Absolute Difference	Relative Diff (%)
Modal	Torsion	Hz	50	50	-4.00E-02	✓
	First Order Bending	Hz	43	43	1.90E-01	✓
	Second Order Bending	Hz	37	37	3.00E-02	✓
	Front End Lateral Bending	Hz	34	34	-1.00E+02	✓
Static	Torsion	kNm/°	22.0	21.9	-1.30E-01	✓
	Bending	kN/mm	15.9	15.5	-4.20E-01	✓
Mass	BIW + Glasses + IP beam + NSM	kg	407.5	402.5	-5.54E+00	✓

FRONT END LATERAL MODE
MaX_NVH_test05.h3d
Mode 7 - F = 33.5 Hz

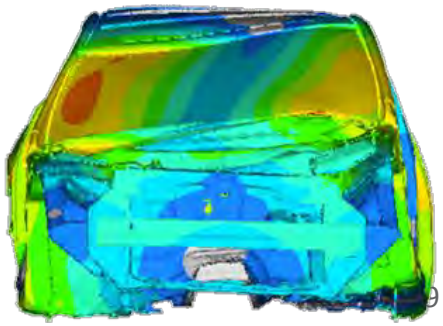
SECOND ORDER BENDING MODE
MaX_NVH_test05.h3d
Mode 8 - F = 37.0 Hz



FIRST ORDER BENDING MODE
MaX_NVH_test05.h3d
Mode 9 - F = 42.7 Hz



TORSION MODE
MaX_NVH_test05.h3d
Mode 11 - F = 50.0 Hz

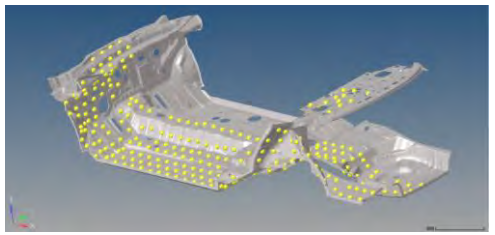


Status: NVH Global (Analysis performed at BiW level)

Acoustics

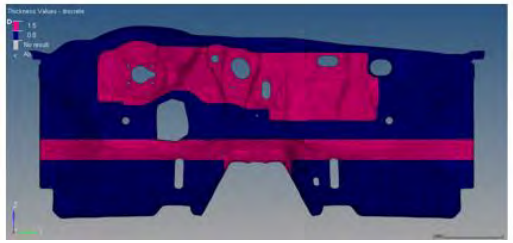
> Preliminary acoustic studies were performed by assessing BiW panel mobility
> MaX solution shows a similar level of performance compared to the baseline final model

— Mobility points :

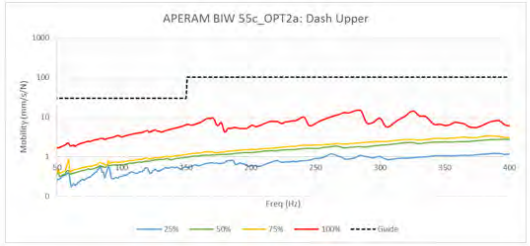


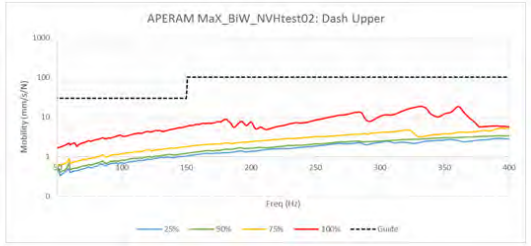
Panel mobility is assessed by applying a unit load normal to the panel surface and calculating the resulting velocity across all panels

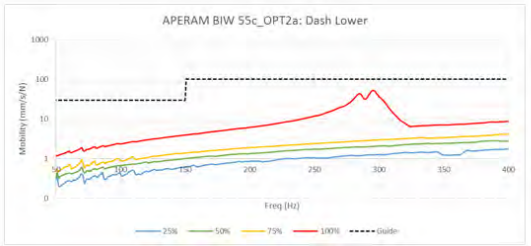
—Example - Dashboard Mobility:

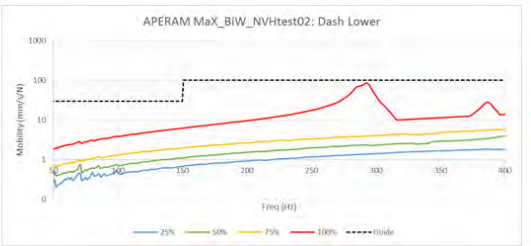


Dashboard panels exhibit low levels of mobility. MaX solution satisfies guidelines and shows only a minor difference in performance over the baseline. Note that the increases observed are likely to be at only a few points where refined geometric improvements may help.



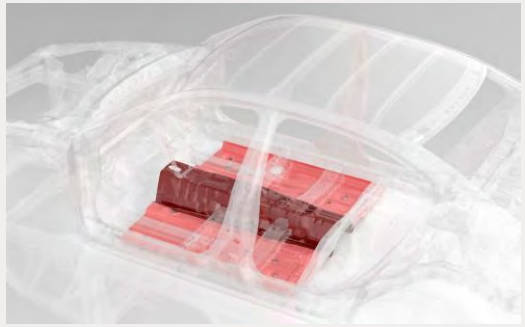




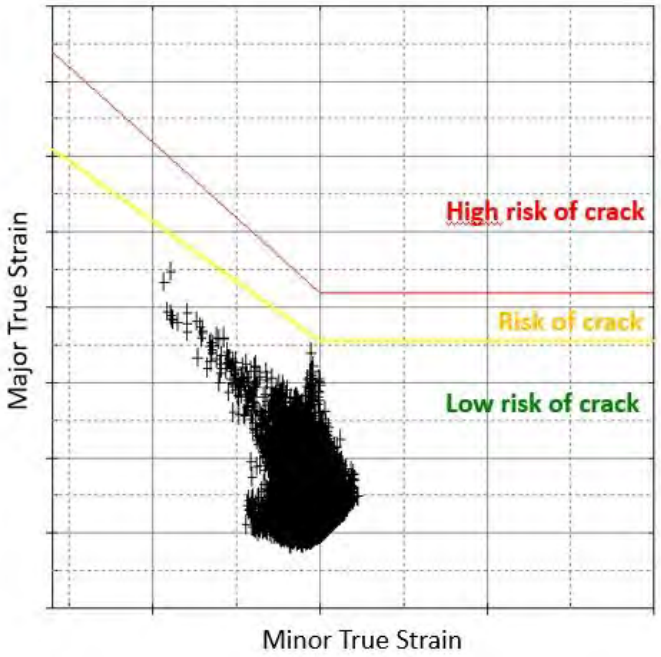


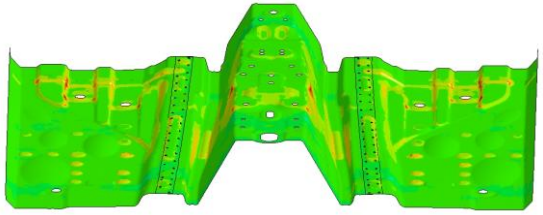
Feasability

Front Floor



Right and Left
+ tunnel integration
From 7 parts to 1 using TWB technology





More and more manufacturers are using hot stamping parts. We propose the innovative concept of joining a low thickness part and a TWB. By taking advantage of reinforcement integration, only one part needs to be produced.

Cost Analysis

Costing syntese MaX et Baseline

Baseline

MaX

PRF	Invest.
0 %	-75 %

Partners

Partnership

Aperam goes beyond material development.
By working directly with car manufacturers, we are able to understand their challenges and find solutions to satisfy actual application needs. As a result, Aperam is able to offer solutions for the automotive market.

We work with specialised partners to test MaX in terms of simulation, crash resistance and feasibility.

Altair:
crash and NVH simulations, structural optimisation

Bertrandt Engineering:
costing

Conex:
prototypes and feasibility

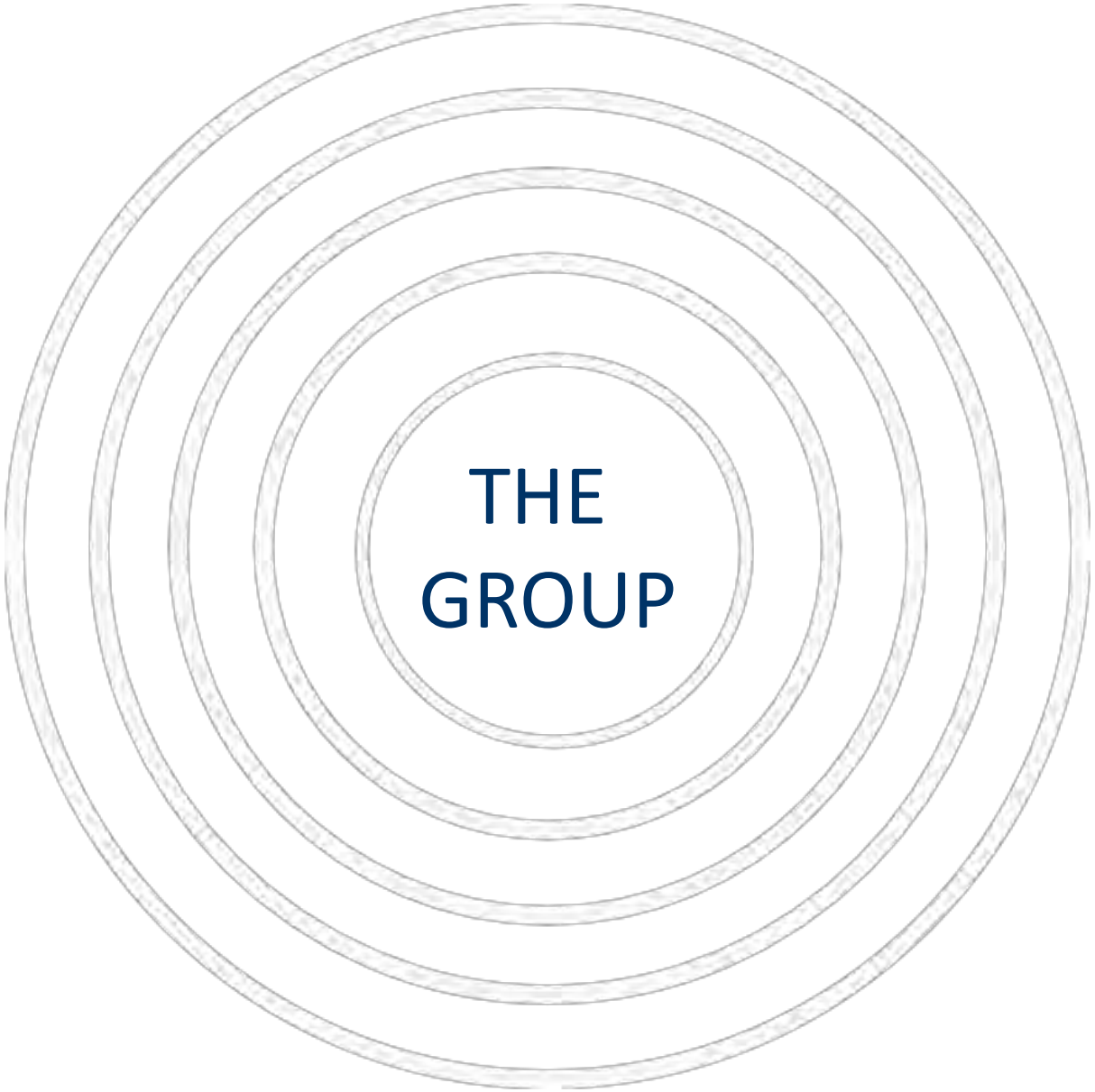
Schuler:
feasibility and real industrial trials

Oerlikon:
feasibility analysis

Magnetto Automotive:
real industrial trials

CLN GROUP

Focus on the Group and its core business


THE
GROUP

The Group is active in:

METAL FORMING

MA | automotive components

MW | steel wheels

RE-ROLLING

ITLA BONAITI

STEEL SERVICE CENTRES

SSC | Slovakia

ArcelorMittal CLN

- Delna | Tamagnone
- Centro Servizi Metalli
  Centro Servizi Navali

TESTS & MEASUREMENTS

| TO PROVE LAB

BEYOND STEEL

| capital venturing

| start-up jvs

Fare clic per modificare lo stile del titolo

Fare clic per modificare stili del testo dello schema

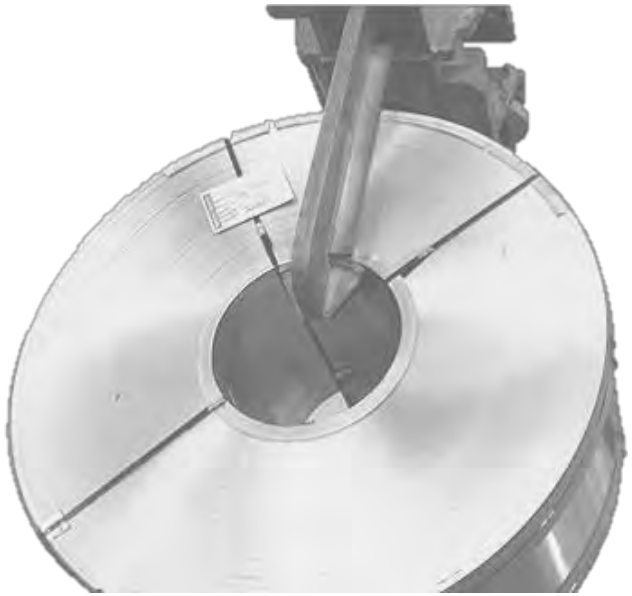
- Secondo livello
  - Terzo livello
    - Qu



Mission and Vision

Fare clic per modificare stili del testo dello schema

- Secondo livello
  - Terzo livello
    - Quarto livello
      - Quinto livello



The Group Profile

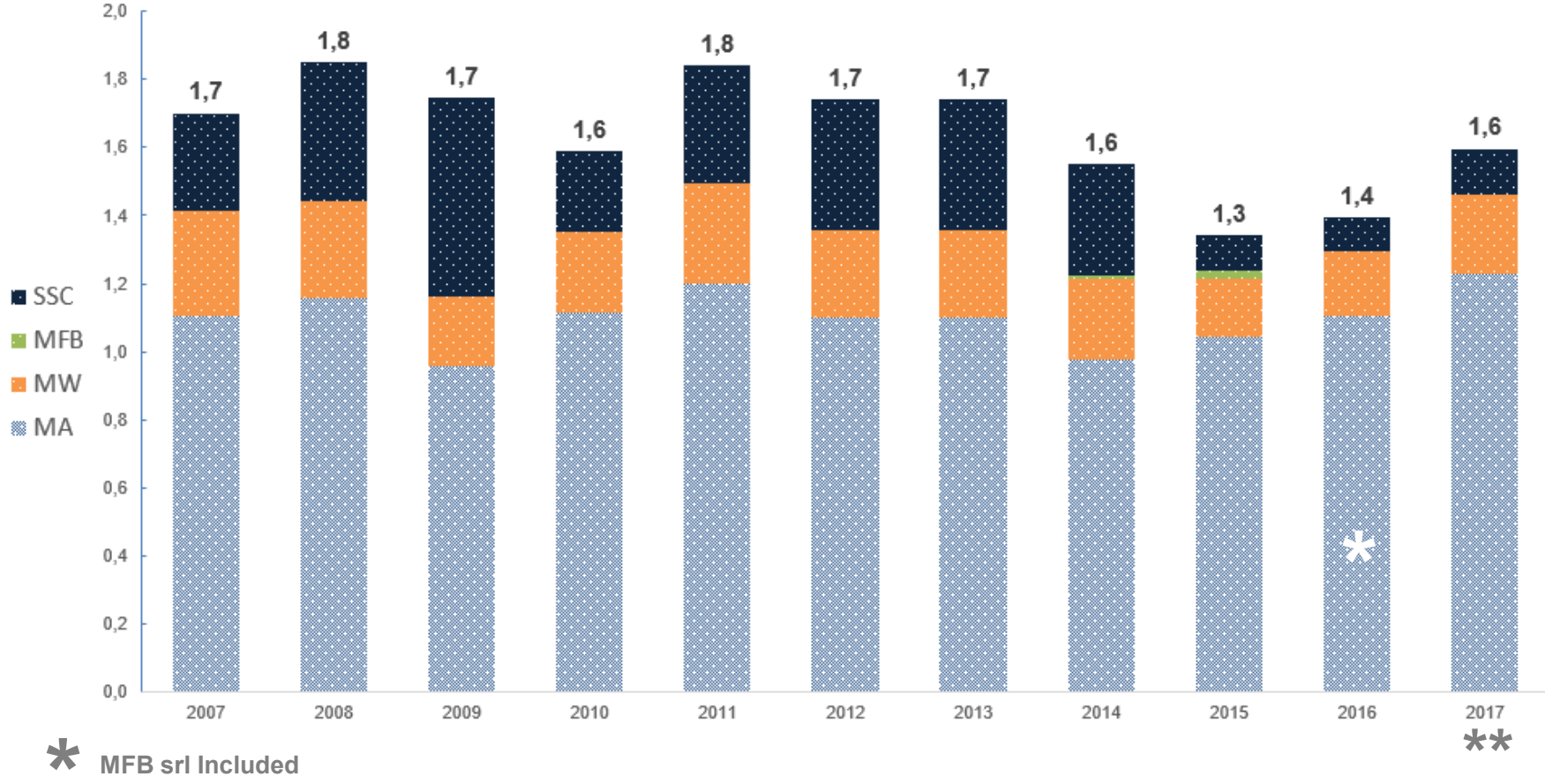
Fare clic per modificare stili del testo dello schema

- Secondo livello
  - Terzo livello
    - Quarto livello
      - Quinto livello

* *including only subsidiaries*

data source: 2017 Annual Report

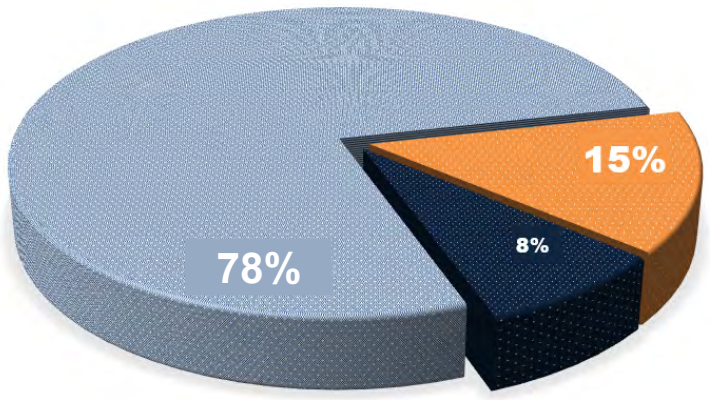
2017 Group Consolidated Turnover: 1.6 Billion Euros



* MFB srl Included

** 2017 Additional SSC turnover from ArcelorMittal CLN Group:
Net Sales: 790 mln Euros
(until 2015 included)

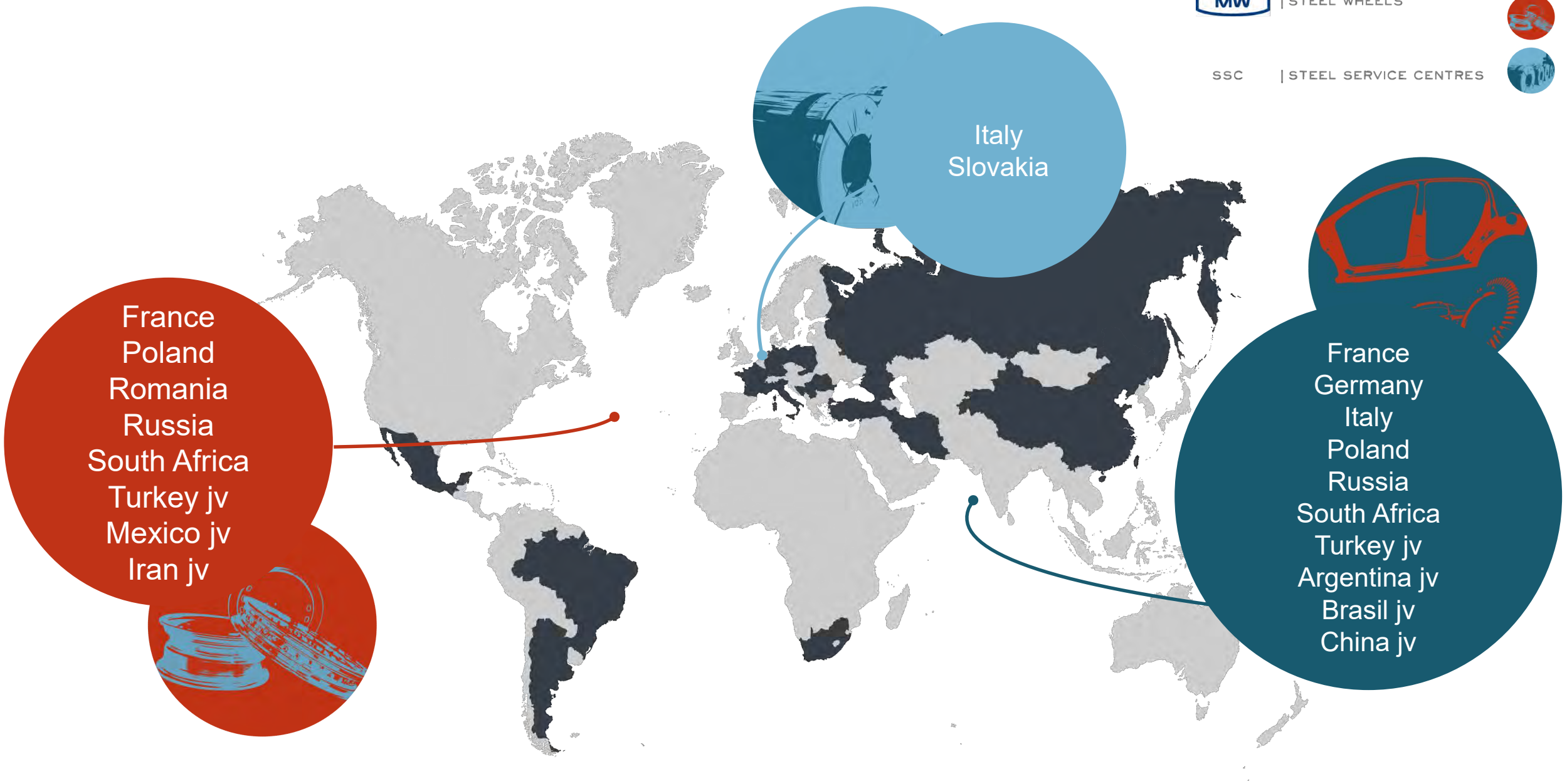
Turnover by Division



MA | AUTOMOTIVE COMPONENTS

MW | STEEL WHEELS

SSC | STEEL SERVICE CENTRES

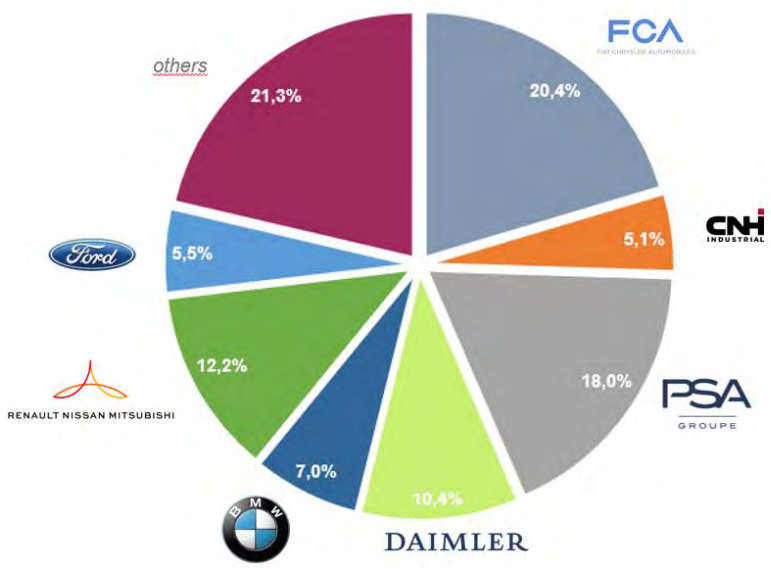


THE DIVISIONS

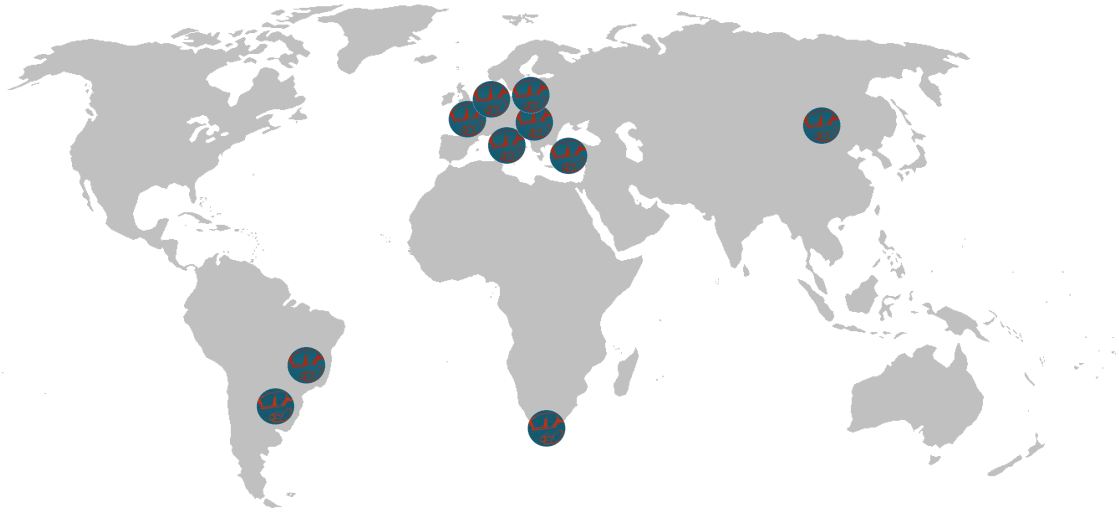
MA | The Metal Automotive Components Division

Specialized in metal forming (**stamping**, **rollforming** and **assembling**) of automotive structural parts, components, subassemblies and modules.

Sales by Customer
data source: sales 2018



26 plants (21+5 in jv)
10 countries
5824 employees
3 R&Ds



MA | The Product Range

MA produces **steel** and **aluminium** upper and lower body structures, inner and outer panels, car closures, as well as components for powertrain and transmission, and provides an extensive range of engineering solutions for passenger cars and commercial vehicles.

Vehicle Body parts

Under Body

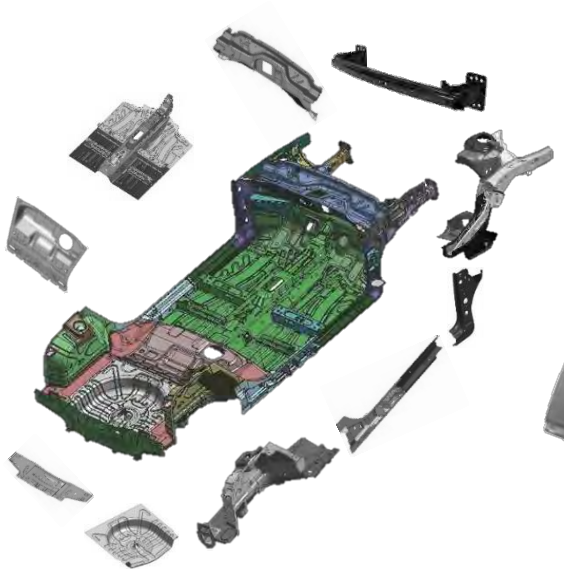
Closures

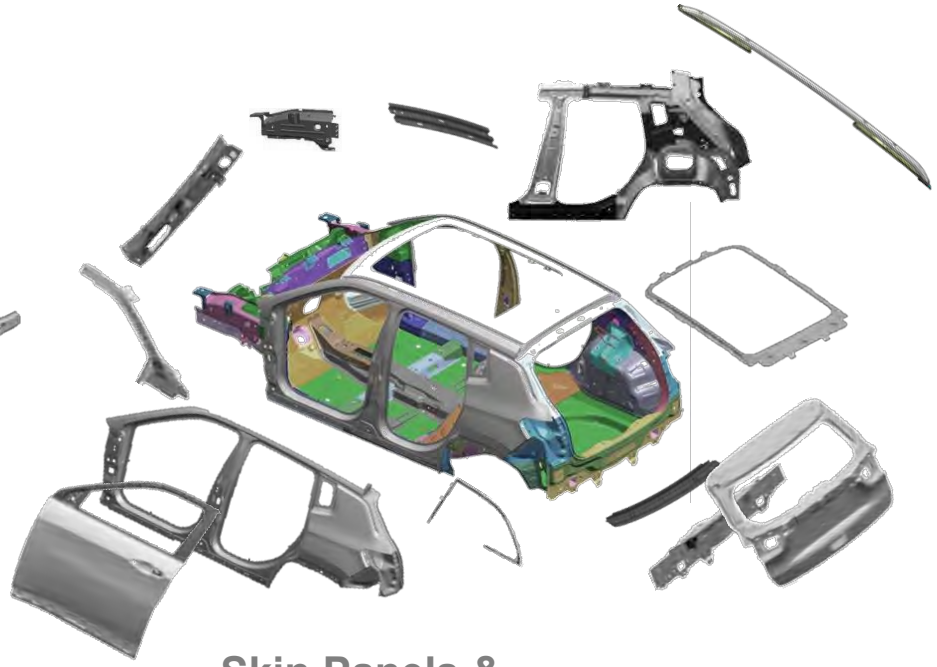
Body in White

Body

Structure

Chassis & Suspensions





Skin Panels & Closures

Rollformed

Fine blanking parts
Stamping parts
Deep drawing parts
Axles components
Vehicle suspension parts
Wiper system parts
Seat components
Window lifting frames
Brake systems
Gear box parking systems
Gear Box Forks Actuators
Oil Pump Covers
Door locks

MW | The Steel Wheels Division

Steel wheel market leader for passenger car and light commercial vehicle types (MW).
Each model is designed, tested and manufactured with the guarantee of top safety standards

8 plants (5+3 in jv)
1419 employees
19.5 mln pcs production capacity

15 disc lines (12”-20”)
18 rim lines
21 assembly lines (12”-20”)
17 paint lines (12”-20”)

MW | The Steel Wheels Division

Sales | mainly in direct sales to OEMs and in the aftermarket business with a dedicated Sales network.

Styled wheels | the result of R&S and Design/Technical Engineering efforts for advanced styling, significant cost reduction *vs* aluminium wheels, attractive and custom-made design, and lightweight solutions.

STEEL WHEELS
FOR PASSENGER CARS

STEEL WHEELS
FOR
LIGHT COMMERCIAL VEHICLES

STYLED WHEELS FOR
PASSENGER
CARS


STEEL
SERVICE
CENTRES

SSC | Steel Service Centres

Transformation and distribution of flat steel products for various end-uses, from automotive to household appliances, as well as other general industrial applications where steel sheet is used.
The network counts a steel distribution centre in Slovakia.

Flat steel products
coils
narrow strips
trapezoid
sheets and blanks
hot rolled pickled
oiled cold rolled
hot dip galvanized
colour coated
electrogalvanized
aluminized steel
alusi

Service
cut to lenght
slitting
warehousing
shipping
just in time deliveries

Plant

SLOVAKIA C.L.N. SLOVAKIA S.R.O. - Kosice

Cold Rolled Steel | ITLA Bonaiti

ITLA Bonaiti is the upshot of the joint venture* between
Itla Srl and Giuseppe & F.lli Bonaiti S.p.A. and is the largest Italian group in the field of cold-rolled quality steel, with a consolidated production capacity of over 120,000 tonnes/year.

ITLA Bonaiti was born on September 1st, 2017.
A CLN Group consolidated company.

itlabonaiti.com

** Steel wire production is excluded from the jv*

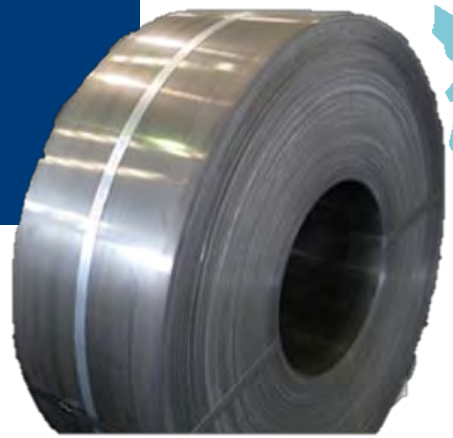
ITLA Bonaiti | Key data

itlabonaiti.com

Headquarters
via per Dolzago, 69 - 23848 Oggiono (LC)

Plants
Oggiono (LC)
Palazzago (BG)
Mogliano Veneto (TV)
Civate (LC)

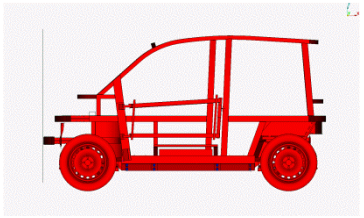
Start of operation	**01/09/2017**
Employees	**150**
Sales	**90 kt/y**
Turnover	**100 million Euro**
Production sites	**4**



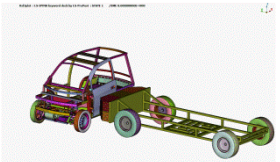
Electrical mobility:

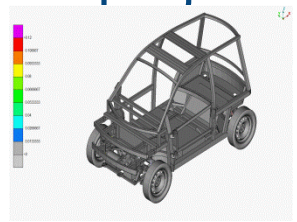
R&D activities | e-car Programs / European Union incentivated projects

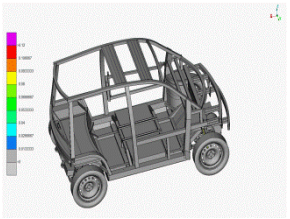
- Grades / Design optimization
- Design modular parts in order to use the same welding fixtures
- Reduction of BIW parts
- Safe vehicles (crash / ENCAP)
- Battery pack

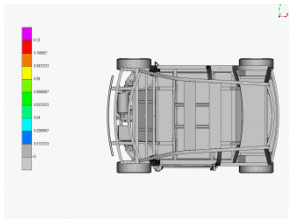


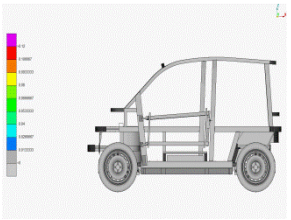
Dual Phase (600, 800, 1000) vs S235JR







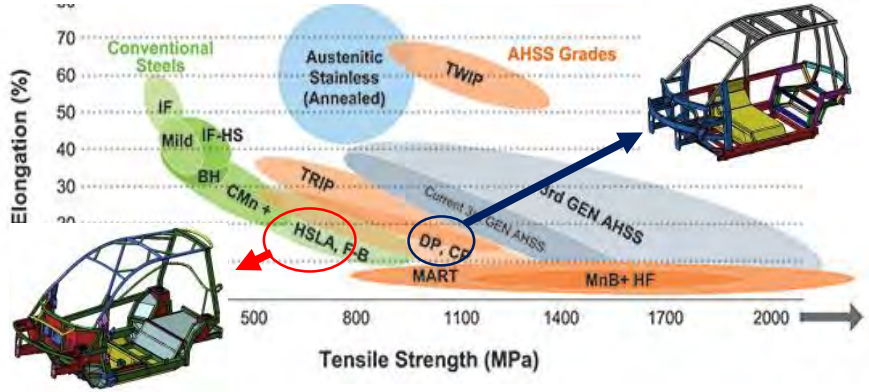




PLUS MOBY

see the project on Euronews

MA involvement: definition of steel grades, architecture, cost engineering, industrialization scenarios



Plus Moby – FP7
https://cordis.europa.eu/project/rcn/110642/factsheet/en
Project Value:3,5 M €

Steel S4EV – RFCS
Project Value: 1,16 M €

9/2013 9/2016 10/2017 9/2018 10/2020 09/2021

DEMOBASE – H2020 – SAFT
www.demobase-project.eu
Project Value: 7,5 M €

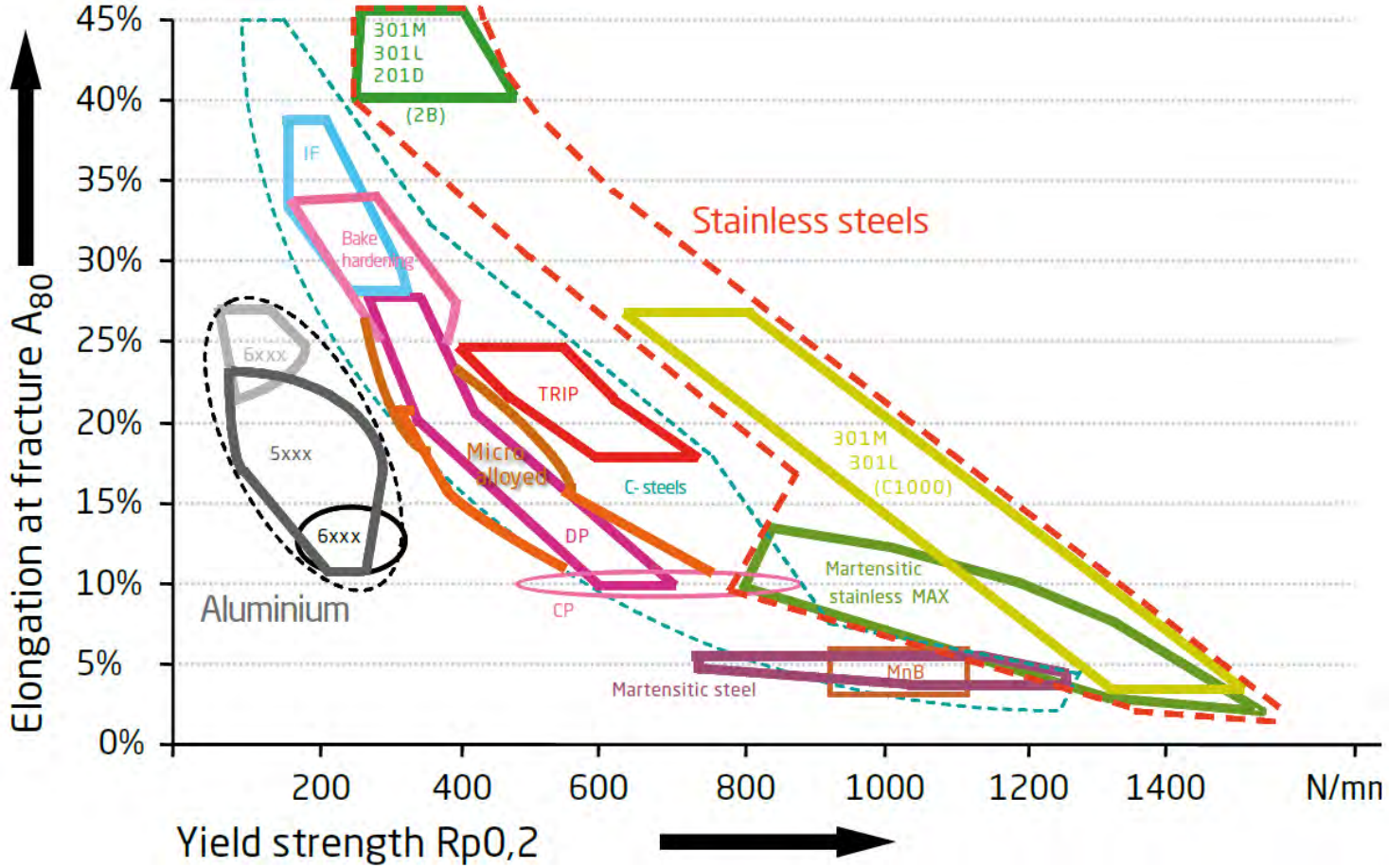
Poli Model

MA Division | Direct hot forming process

Inner parts/ structural parts
Complex geometry with high strength resistance

Press type	Hydraulic
Max force	12000 kN (1200 T)
Max material size	2100x2100mm
Material type	22Mn B5 Coated, AlSi
Material thickness	0.8 – 3 mm
Furnace, Max temp	970°C
Dew point control	<<-10°C,
Temperature control	15 control zones

Feasibility studies of automotive structural components by using stainless steels

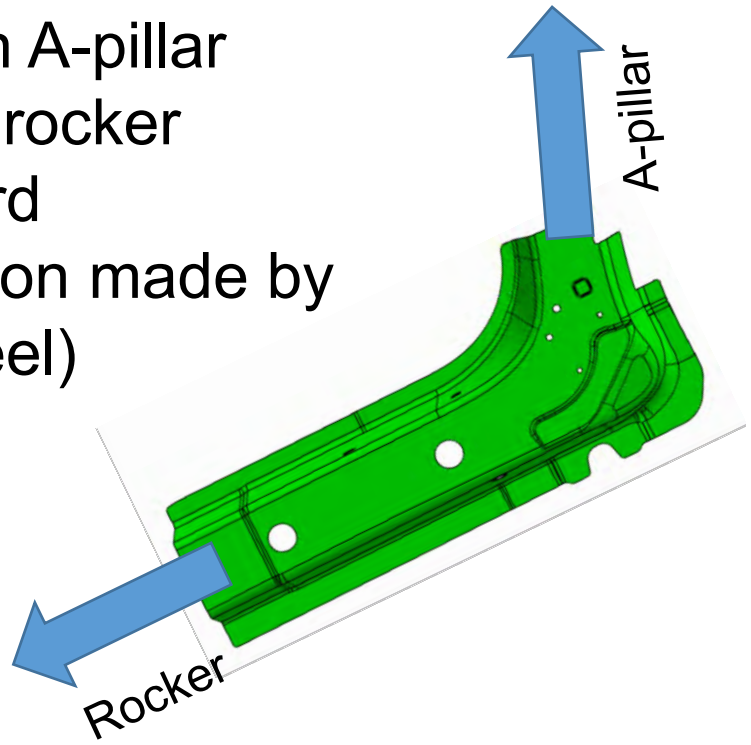


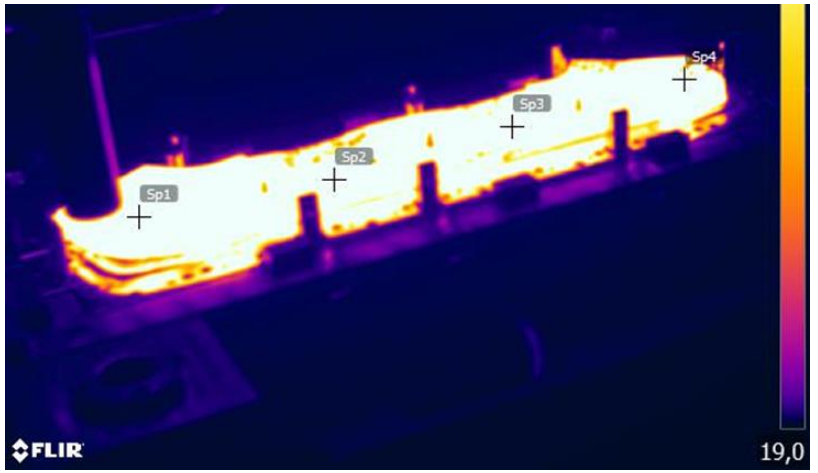
Why stainless steels?

- At the same strength level they have much more elongation (Martensirtic in comparison to standard MnB)
- At the same elongation they have much more strength (Austenitic in comparison to standard DP)

1st case study: direct hot forming of MAX martensitic stainless

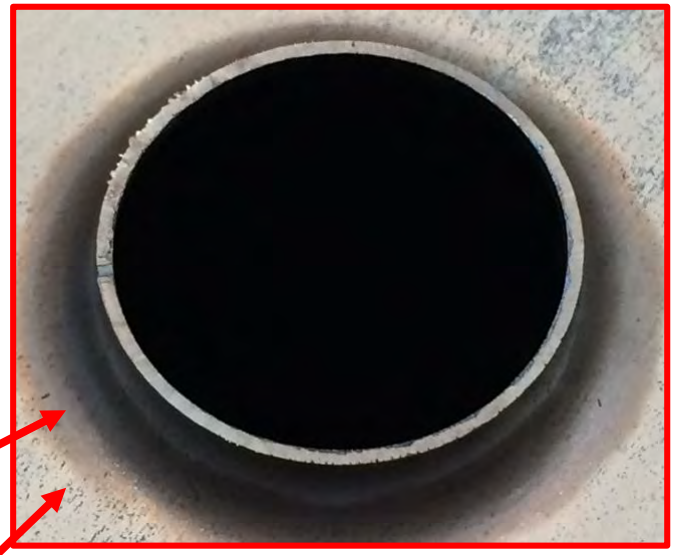
Connection between A-pillar and the rocker (standard production made by MnB steel)



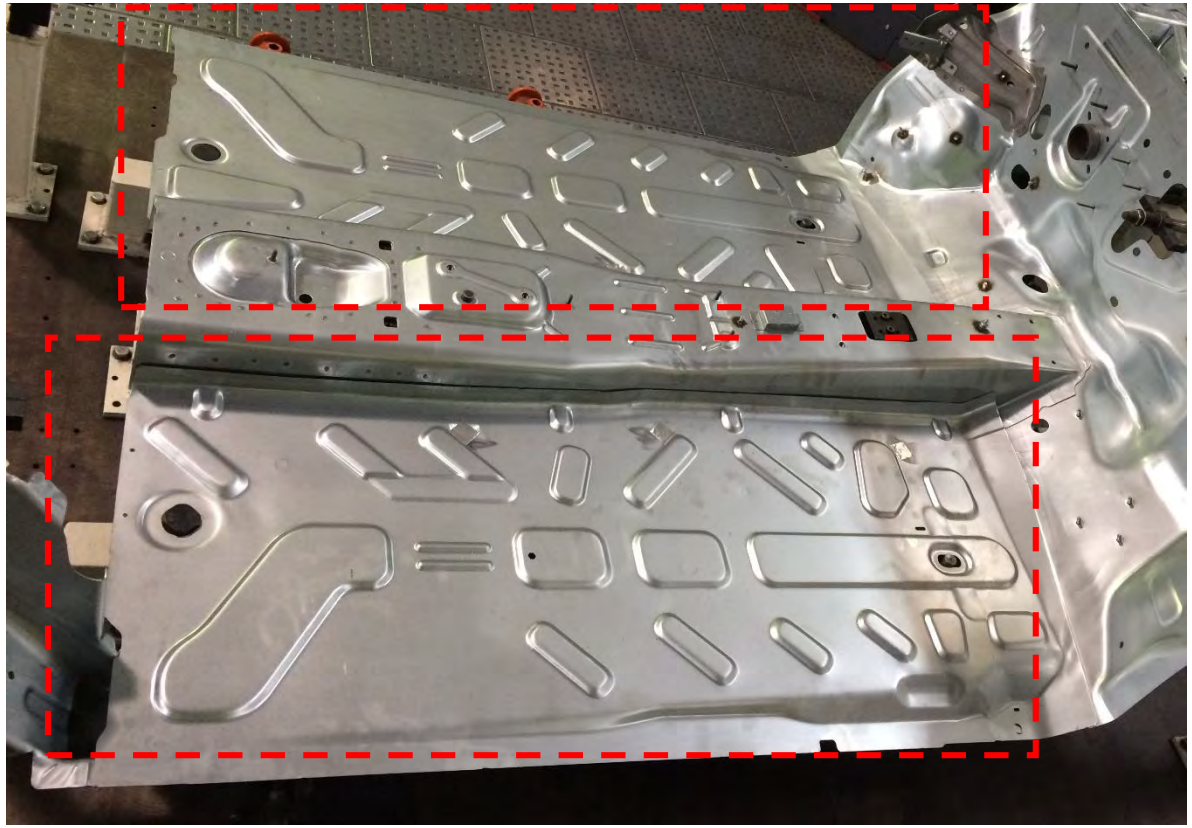


1st case study: direct hot forming of MAX martensitic stainless

Final parts obtaned by using standard procedures. Good results in therms of hole expansion.



2nd case study:
indirect hot forming of MAX martensitic stainless



Floor panels cold stamped with standard DP600 0,8 mm thickness

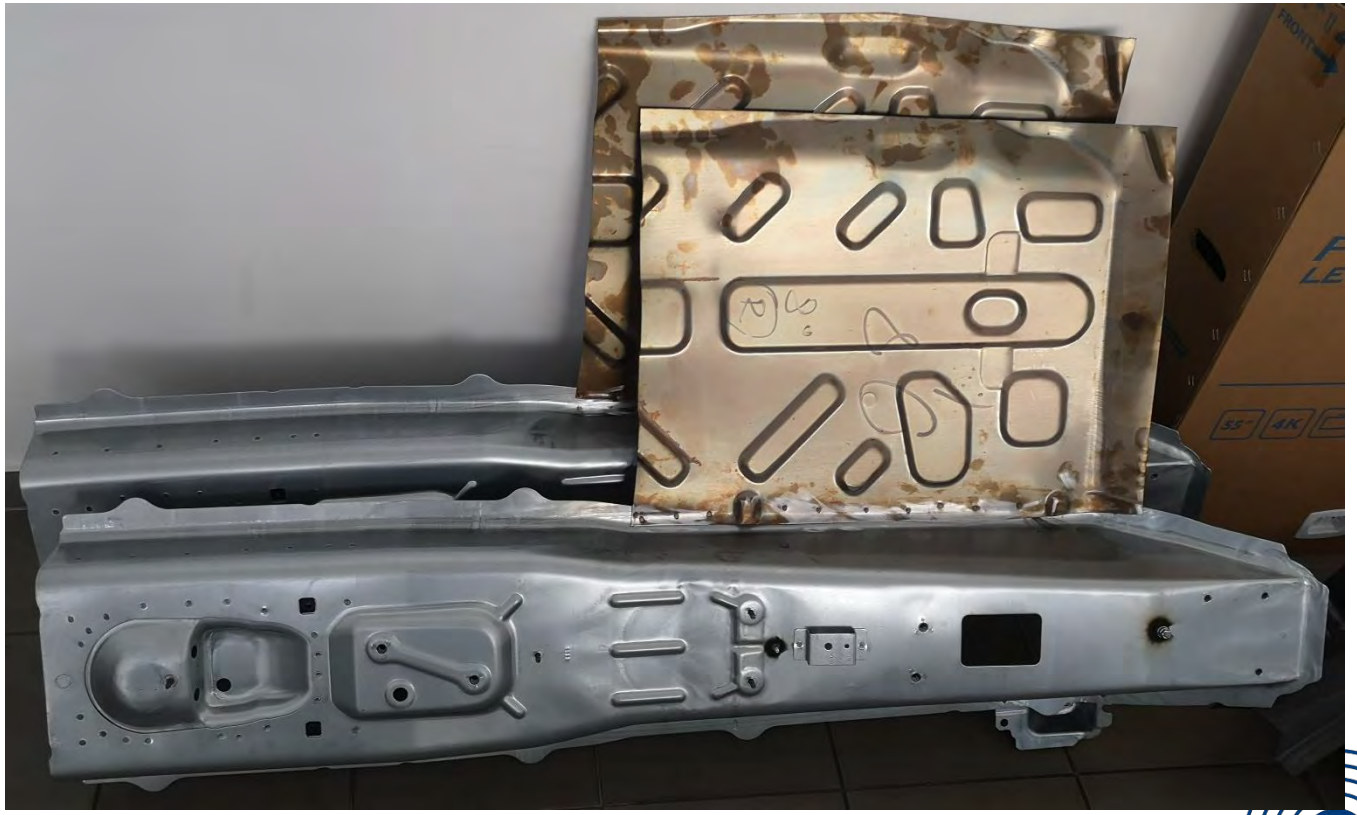
2nd case study: indirect hot forming of MAX martensitic stainless

Standard DP600 – 0,8 mm

Cold formed MAX – 0,8 mm

2nd case study: indirect hot forming of MAX martensitic stainless

The cold formed panels were been heat treated and assembled as archetypes of the standard floors



Conclusions

- CLN Group and MA/MW are well present in automotive market, with plants serving all major OEMs
- From mother coil to final assemblies, with mastership of AHSS (long last experience with major steel suppliers), using all processes (Hot forming, cold forming and roll forming)
- Working closely with steel suppliers/OEMs/…, we are able to propose smart solutions for weight-saving & cost efficiency
- Manage the full steel chain, from virtual analysis to prototyping and significant parts (automotive and other sectors)
- With our experience, we can propose, together, the optimal industrialization scenarios for cost saving and help our customers to have the best compromise
- The support of steel/alu - maker is fundamental

Stay tuned!

gruppocln.com

Aperam is the leading Stainless and Specialty Steels company in South America and the second largest in Europe. We are also a leading manufacturer of high value added specialty products. including electrical steels and nickel alloys.

From machinery to cutlery. we take pride in manufacturing products that last a lifetime. offering great strength and versatility to our industrial customers and end users.

Together with our values of Leadership. Ingenuity and Agility. we aim to reshape the future of our industry by creating products that solve global challenges and serve as catalysts for change.

aperam
made for life

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