GREAT DESIGNS IN STEEL

TWENTY YEARS

MULTI PART INTEGRATION™ (MPI) CONCEPTS USING PRESS HARDENED STEEL LASER WELDED BLANKS

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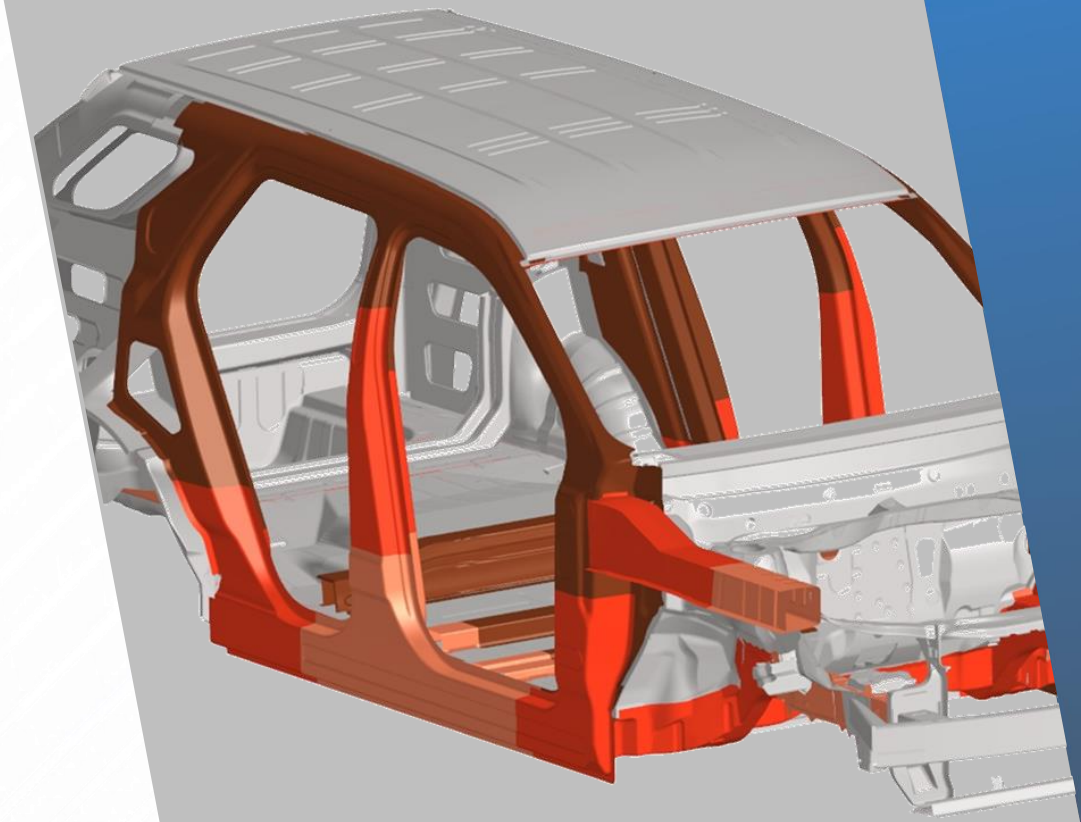
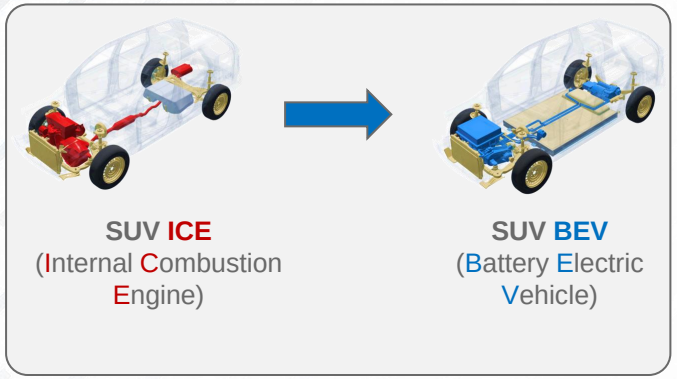
ArcelorMittal Tailored Blanks Americas

AGENDA

- Impact of electrification to vehicle architecture
- Evolution of Laser Welded blanks
- AMTB's Multi Part Integration™ (MPI) concepts for EVs
- Rear Rail Assembly MPI Concept Case Study
  - Part Integration
  - Commonality & Modularity
  - Weight Reduction
  - Forming Feasibility
  - Crash Management
  - Performance Validation
  - CO_2 Emissions Reduction
  - Material Utilization
  - Cost Optimization
- Conclusions

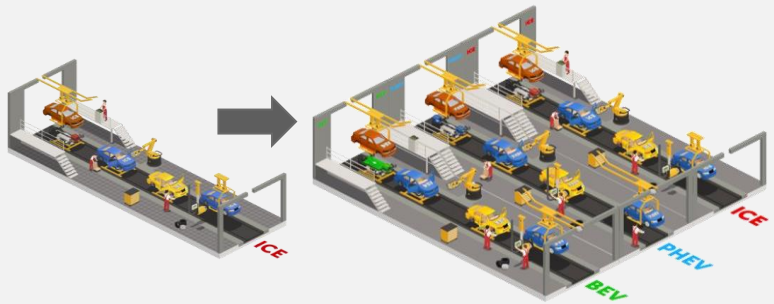


IMPACT OF ELECTRIFICATION TO VEHICLE ARCHITECTURE

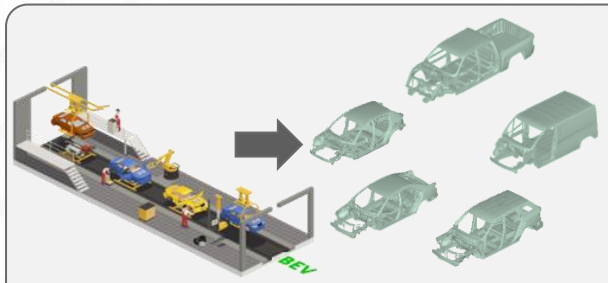


SUV ICE
(Internal Combustion Engine)

SUV BEV
(Battery Electric Vehicle)



Retooling of existing ICE platforms



- Low volume
- Multiple segments
- Modular platform
- Scalable designs

Dedicated BEV platforms

Opportunities in Electrification

- Platform diversity
- Battery cell integration
- Low volume production
- Smaller Carbon footprint
- New body shop investment

Innovation Goals

Lightweighting

Cost optimization

Vehicle safety

Sustainability

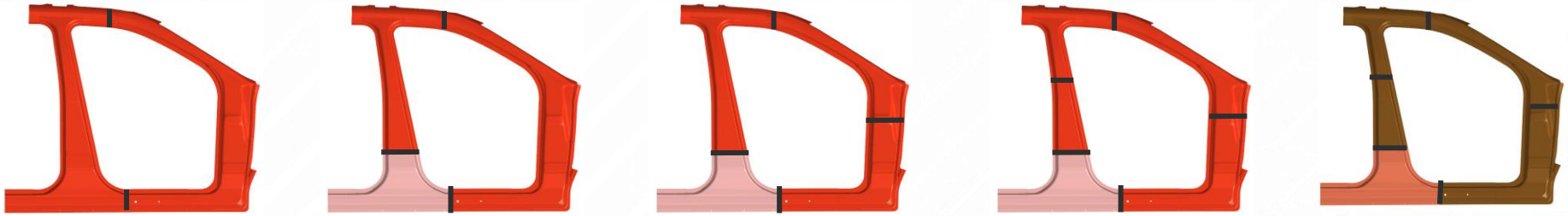
EVOLUTION OF LASER WELDED BLANKS

- The Multi Part Integration™ (MPI) concepts are the next innovative design using laser welded blanks (LWB) **developed by AMTB and AM Global R&D**

Laser Welded Blank Complexity Evolution

Linear welding (Mild and HSS) | Curvilinear welding (Mild and HSS) | Short weld parts (HSS and AHSS) | Short weld parts (PHS) | Door Rings (PHS)

Door Ring Complexity Evolution



2 seam | 3 seam | 4 seam | 5 seam | 5 seam with New Gen PHS

MPIs – The next step in LWB evolution

- PHS 2000
- PHS 1000
- PHS 1500
- AHSS 780
- AHSS 600
- HSS 550
- HSS 350
- Mild Steel (CR3)
- Mild Steel (CR1)

- **Stringent performance requirements and CO_2 emissions requirements have led to increasing complexity of Laser Welded Blanks - number of seams and material strength**

AMTB'S MPI CONCEPTS FOR EVs

PHS INTENSIVE MPI DESIGNS

Part integration

Body shop complexity reduction
Lower die investment

Commonality & modularity

ICE - HEV - PHEV - BEV ...

Weight Reduction

Tailored material properties
Gauge optimization
Efficient force transfer

Design Feasibility

Complex geometry

Crash management

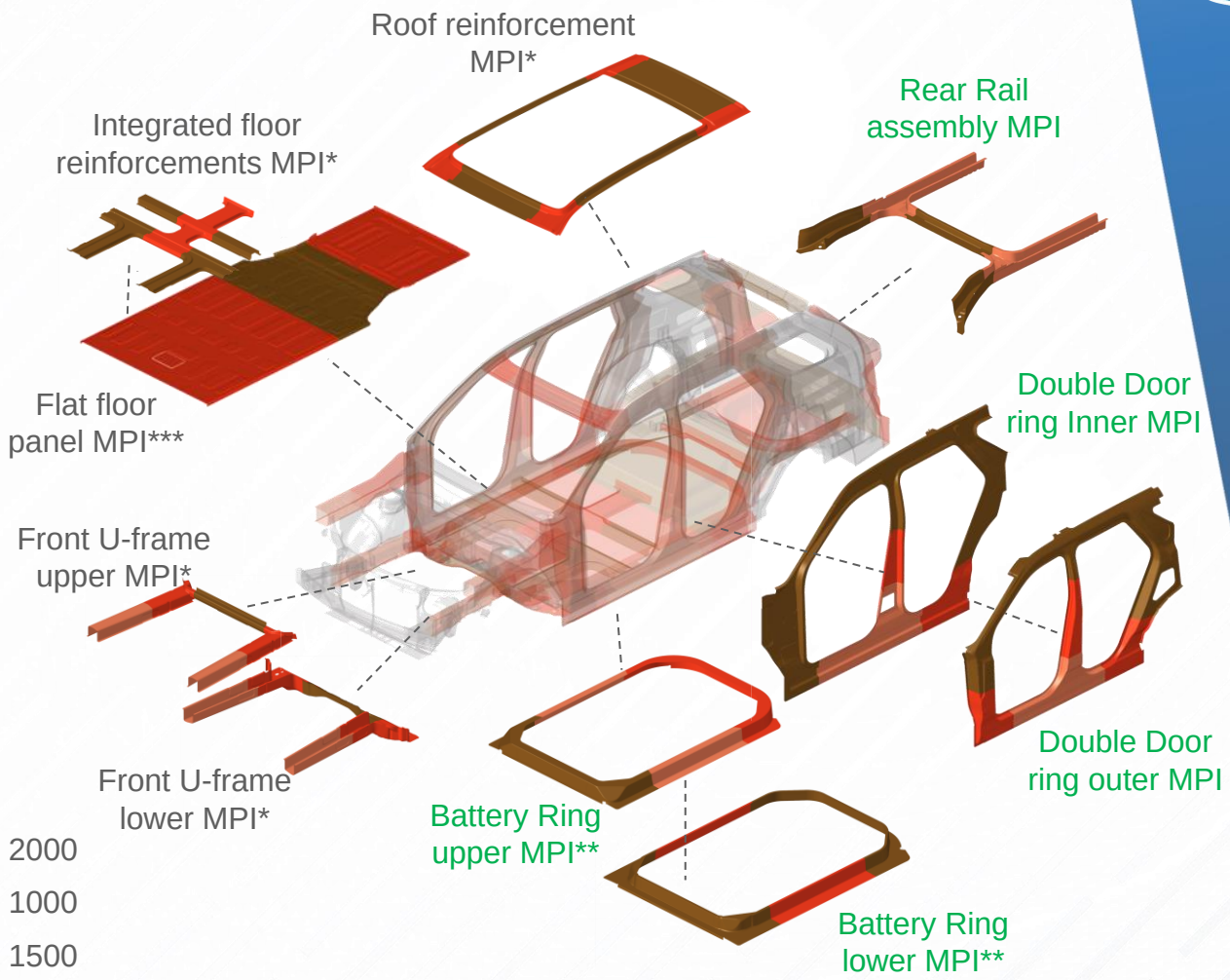
Combined anti-intrusion & energy absorption management: occupant + battery

CO_2 emission reduction

Lower steel production
Lighter vehicle

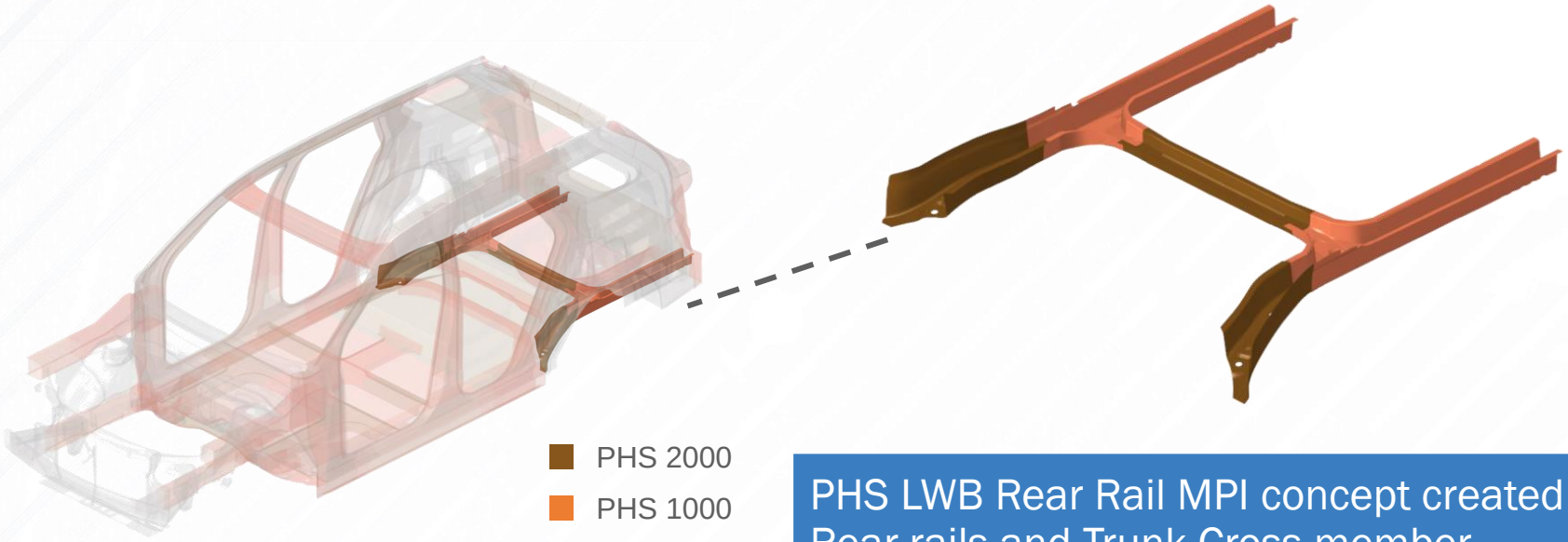
Cost optimization

Function integration
Material optimization
Forming tool reduction
Spot-weld reduction



*MPIs still in development
**Designs presented at GDIS 2021
***Similar to Gestamp's concept presented at IABC 2021

REAR RAIL ASSEMBLY MPI CONCEPT CASE STUDY

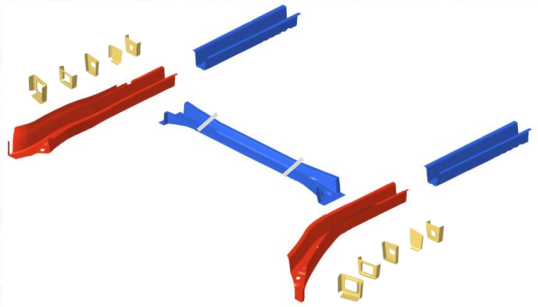


PHS LWB Rear Rail MPI concept created by combining the Rear rails and Trunk Cross member

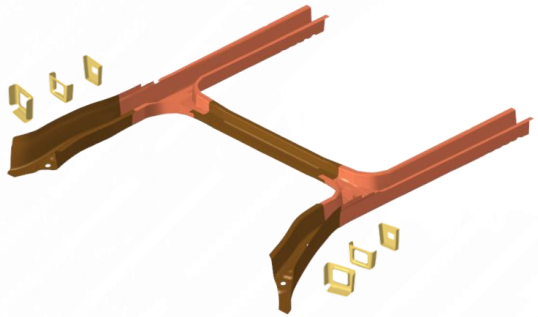
Part integration	Commonality & modularity	Weight Reduction	Design Feasibility	Crash management	CO_2 emission reduction	Cost optimization

REAR RAIL MPI CONCEPT
PART INTEGRATION

Conventional Multipart Design



MPI LWB Design



5 components + 10 bulkheads

Parts in assembly = 15

90 sub-assembly spotwelds

Multiple stamping tools

Multi-stage assembly

1 component + 6 bulkheads

Parts in assembly = 7

24 sub-assembly spotwelds

Fewer assembly operations

Reduced shop floor footprint

Higher geometric complexity & improved accuracy

Part integration

Commonality & modularity

Weight Reduction

Design Feasibility

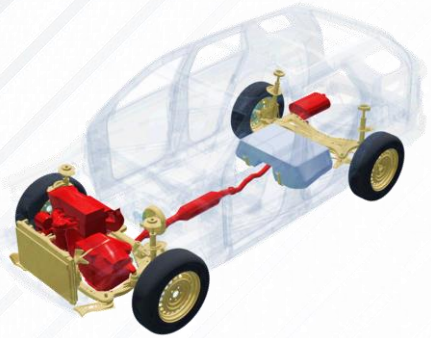
Crash management

CO_2 emission reduction

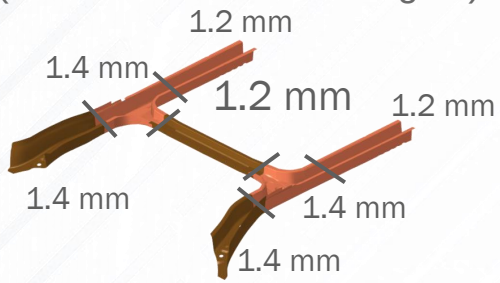
Cost optimization

REAR RAIL MPI CONCEPT

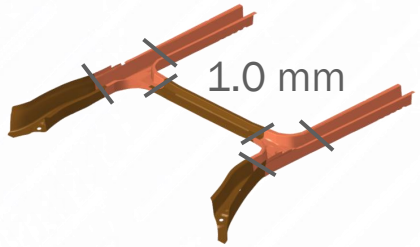
COMMONALITY & MODULARITY



S-in motion® SUV ICE
(Internal Combustion Engine)



AMTB BEV
(Battery Electric Vehicle)



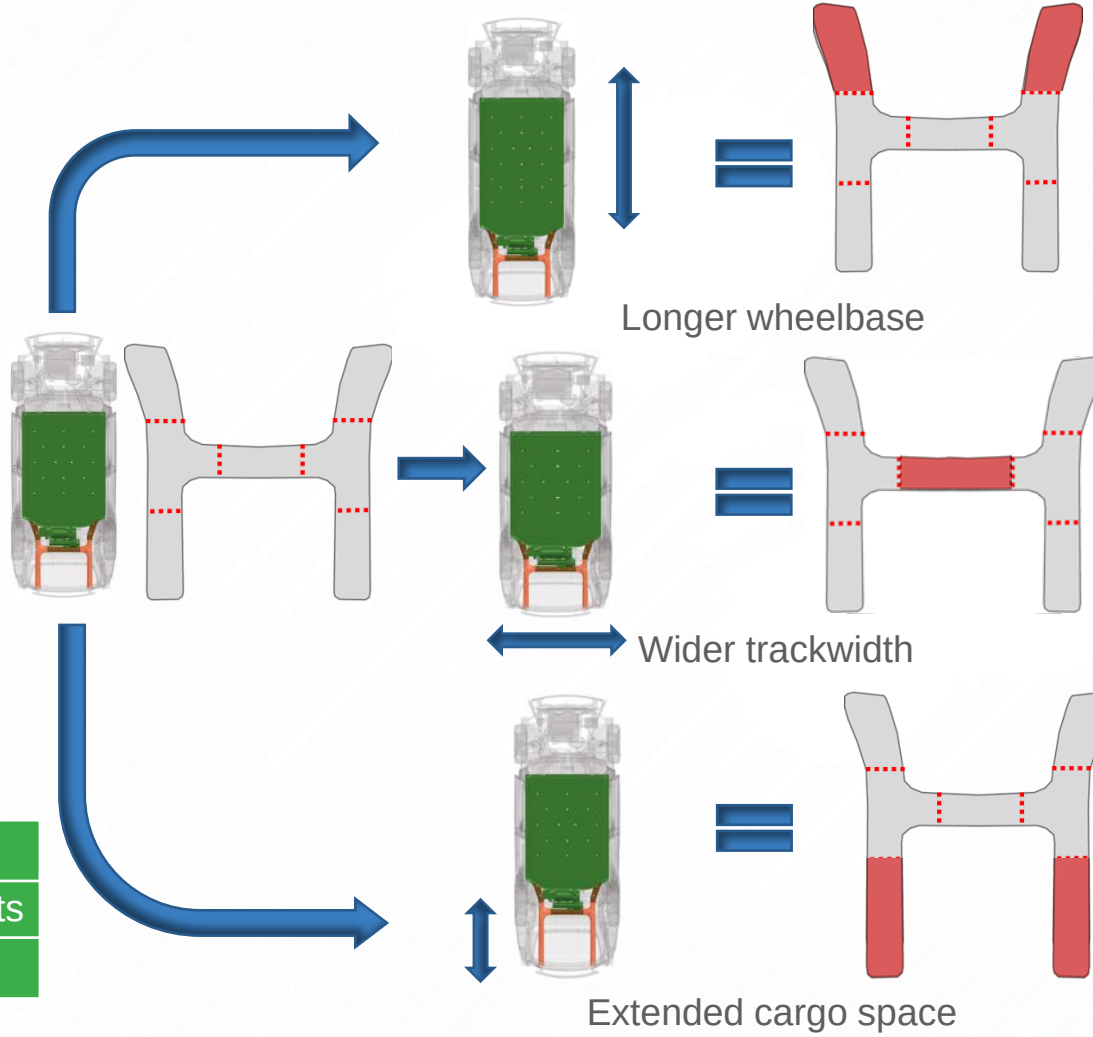
- PHS 2000
- PHS 1000
- PHS 1500

Modularity and interchangeability in design

Gauge/grade optimization per safety requirements

Minimal retooling in manufacturing/assembly

Commonality & modularity



Part integration

Weight Reduction

Design Feasibility

Crash management

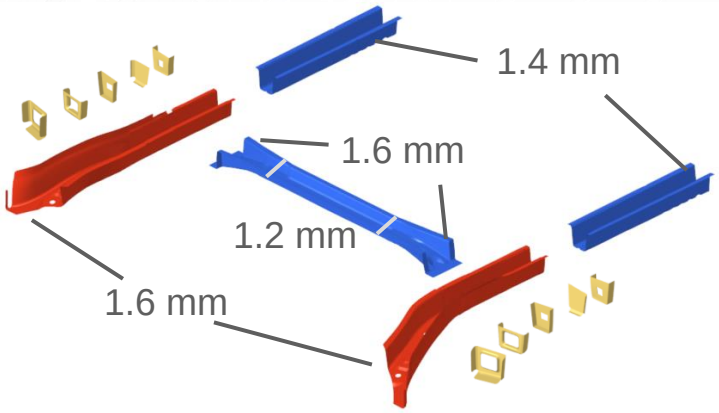
CO_2 emission reduction

Cost optimization

REAR RAIL MPI CONCEPT

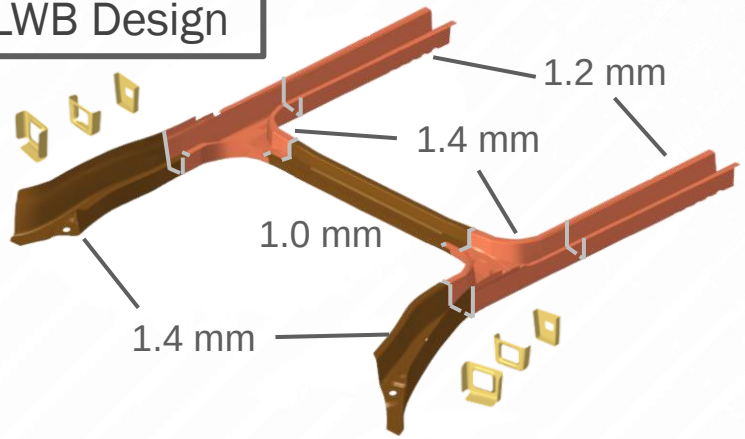
WEIGHT REDUCTION

Conventional Multipart Design



PHS 2000
PHS 1000
PHS 1500
AHSS 600
HSS 350

MPI LWB Design



Parts in assembly = 15

Assembly weight 11.02 kg

Gross weight: 17.75 kg

Material utilization: 62%

Parts in assembly = 7

Assembly weight 8.34 kg
2.68 kg weight saving per vehicle

Gross weight: 11.24 kg
6.51 kg less material used per vehicle

Material utilization: 74%

Part integration | Commonality & modularity | **Weight Reduction** | Design Feasibility | Crash management | CO_2 emission reduction | Cost optimization

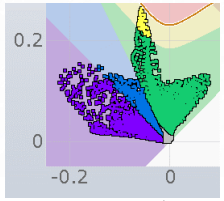
REAR RAIL MPI CONCEPT

DESIGN FEASIBILITY

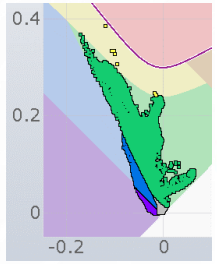
AMTB_BEV_rear_H-frame_sym_modCAD
Time From Start / Distance To Bottom: 0.000 s / 0.00 mm
Operation Step: H-10 Heating
Formability, Middle Layer

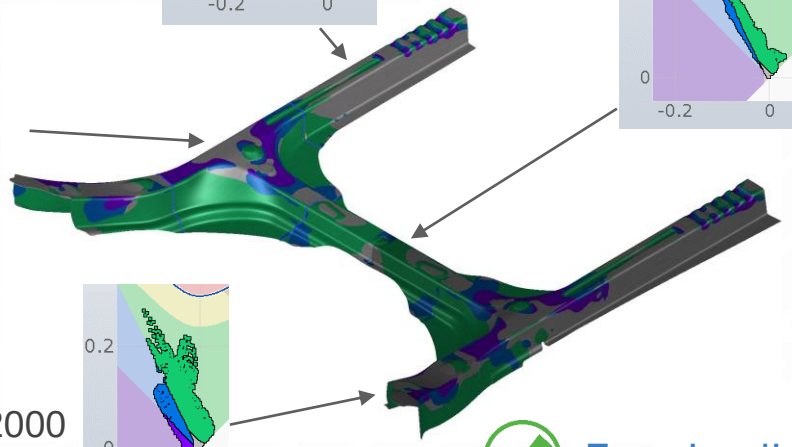
Splits | Excess Thinning | Risk of Splits | Safe | Insuff Stretch | Compress | Thickening

PHS 1000
1.2 mm



PHS 1000
1.4 mm





PHS 2000
1.0 mm

PHS 2000
1.4 mm

Forming limit diagram

Splits	Excessive thinning	Risk of splits	Safe	Insufficient stretching	Compression	Thickening

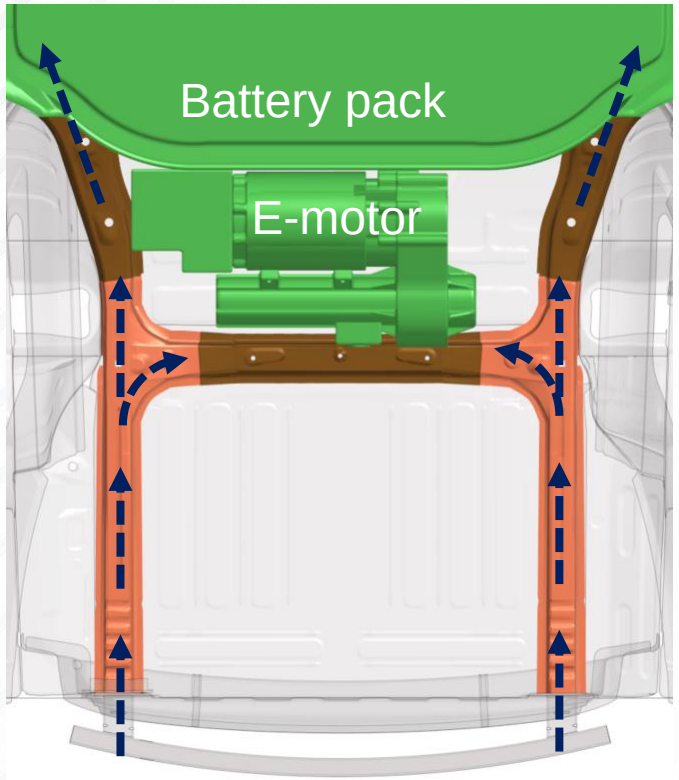
Use of PHS LWBs allows complex geometric shapes to be stamped from a single large blank

Design Feasibility

Part integration | Commonality & modularity | Weight Reduction | Crash management | CO_2 emission reduction | Cost optimization

REAR RAIL MPI CONCEPT

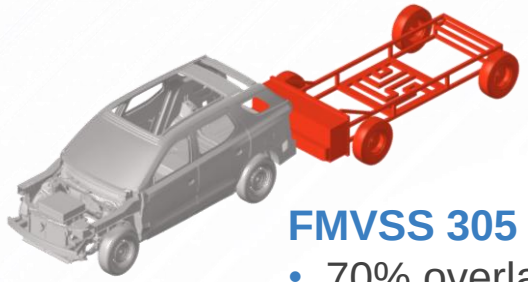
CRASH MANAGEMENT



PHS 2000
PHS 1000

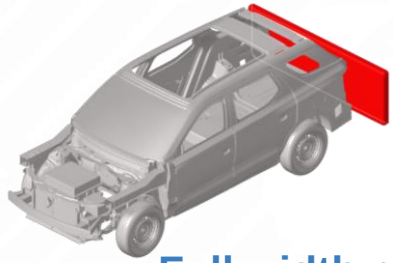
Anti-intrusion with PHS 2000

Energy absorption with PHS 1000



FMVSS 305 rear impact
- 70% overlap
- Deformable barrier
- Initial velocity = 80 km/h

Target
- No contact with battery modules



Full width rear impact
- 100% overlap
- Rigid wall
- Initial velocity = 50 km/h

Target
- No contact with battery modules

Tailored material properties

Continuous load transfer through seams

Validated for NA/EU crash requirements

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | **Crash management** | CO_2 emission reduction | Cost optimization

REAR RAIL MPI CONCEPT

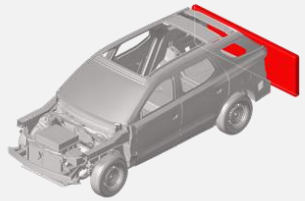
PERFORMANCE VALIDATION

FMVSS 305 rear impact

- 70% overlap
- Deformable barrier
- Initial velocity = 80 km/h

Target

- No contact with battery modules

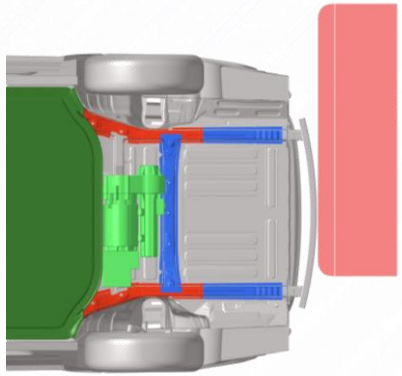


Full width rear impact

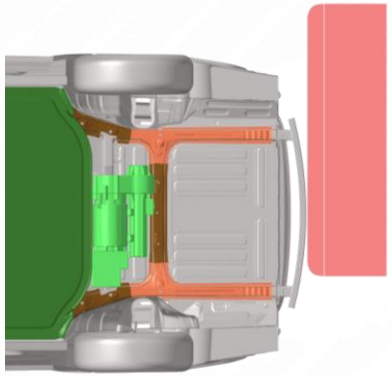
- 100% overlap
- Rigid wall
- Initial velocity = 50 km/h

Target

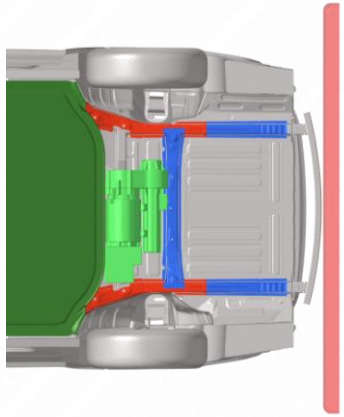
- No contact with battery modules

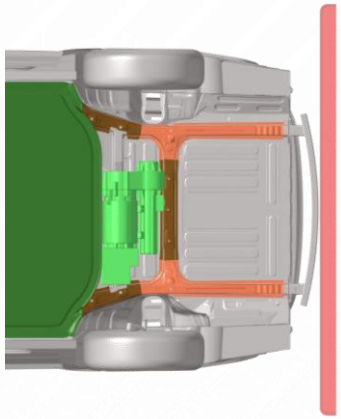


Conventional Multipart Design



MPI LWB Design





PHS 2000
PHS 1000
PHS 1500
AHSS 600

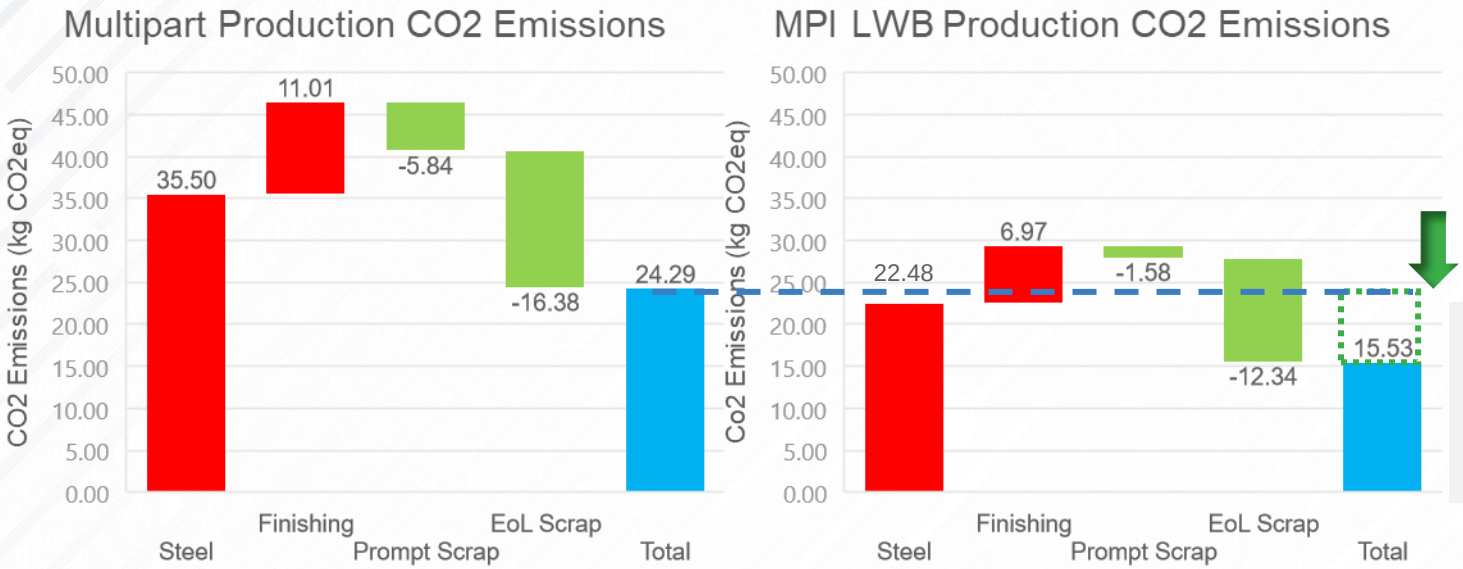
Barrier
E-motor
Battery pack

The Rear H-frame shows improved performance compared to the conventional spotwelded Rear rail design

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | **Crash management** | CO_2 emission reduction | Cost optimization

REAR RAIL MPI CONCEPT

CO_2 EMISSIONS REDUCTION – PRODUCTION



Production phase emissions per vehicle
8.76 kg CO_2 eq savings
36% reduction

Fleetwide savings for 2 million vehicles over 10 years

17 ktonne of CO_2 eq savings during production and vehicle's life cycle:

4 wind turbines

3000 Households of Electricity

20500 Acres of Forest

Calculations done using UCSB Automotive Energy and GHG Model user guide v5 for steel
Calculations based on BEV SUV design implementation
North America steel sourcing used for calculations

Steel Production
- Part weight
- Material utilization
- Gross steel usage

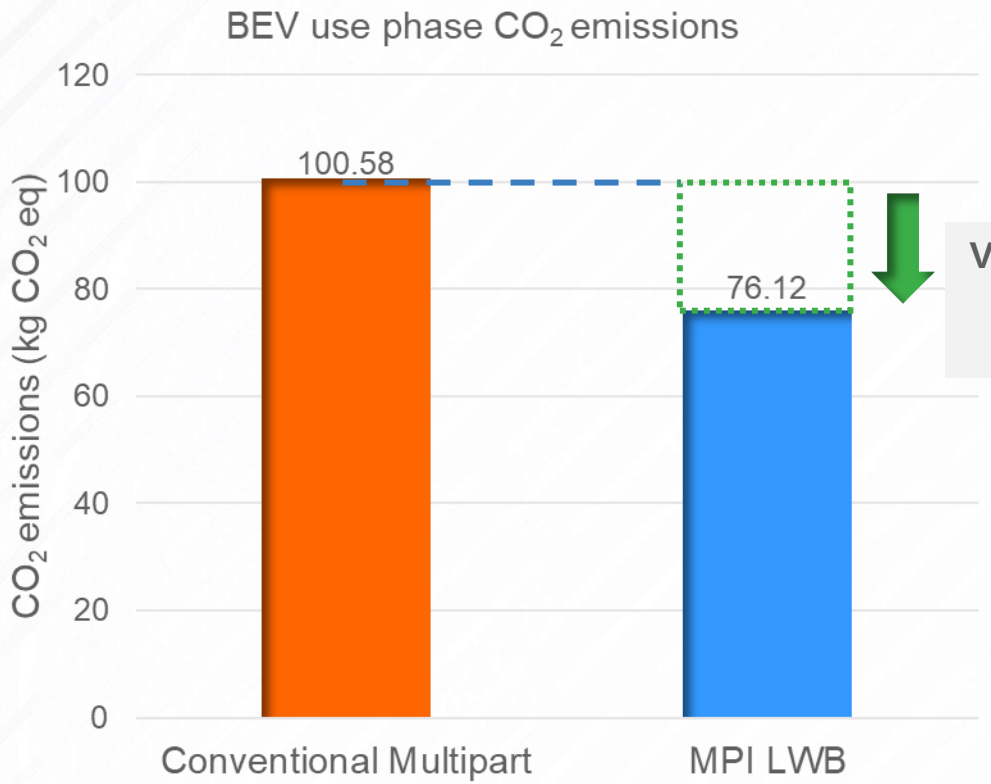
Laser Welding
- Process efficiency

Stamping & Assembly
- Stamping dies
- Assembly stages
- Shop floor space

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | Crash management | CO_2 emission reduction | Cost optimization

REAR RAIL MPI CONCEPT

CO_2 EMISSIONS REDUCTION – VEHICLE USE



Vehicle use phase emissions
24.46 kg CO_2 eq savings
24% reduction

Fleetwide savings for 2 million vehicles over 10 years

49 ktonne of CO_2 eq savings during production and vehicle's life cycle

10 wind turbines

8500 Households of Electricity

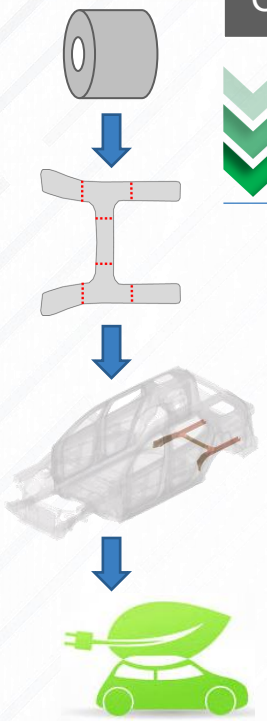
57500 Acres of Forest

Calculations done using UCSB Automotive Energy and GHG Model user guide v5 for steel
Calculations based on BEV SUV design implementation
US charging grid usage considered for calculations
Avg. vehicle mileage assumed at 200,000 kms

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | Crash management | CO_2 emission reduction | Cost optimization

REAR RAIL MPI CONCEPT

CO_2 EMISSIONS REDUCTION – TOTAL



Conventional design

- Lower Gross material used
- Fewer stamping tools
- Fewer Assembly stages/Logistics
- Lighter vehicle

MPI LWB design

Production phase emissions per vehicle
8.76 kg CO_2 eq savings
36% reduction

Vehicle use phase emissions
24.46 kg CO_2 eq savings
24% reduction

Fleetwide savings for 2 million vehicles over 10 years

66 ktonne of CO_2 eq savings during production and vehicle's life cycle

14 wind turbines

11500 Households of Electricity

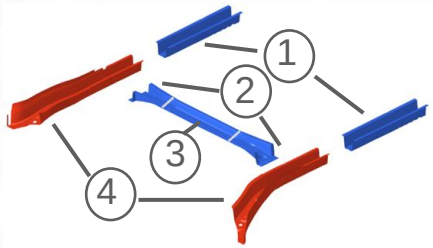
78000 Acres of Forest

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | Crash management | CO_2 emission reduction | Cost optimization

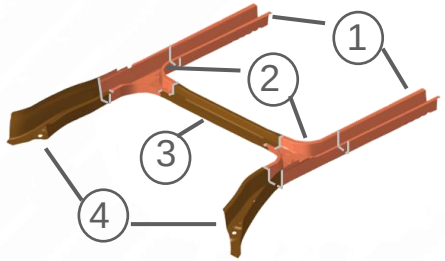
REAR RAIL MPI CONCEPT

MATERIAL UTILIZATION

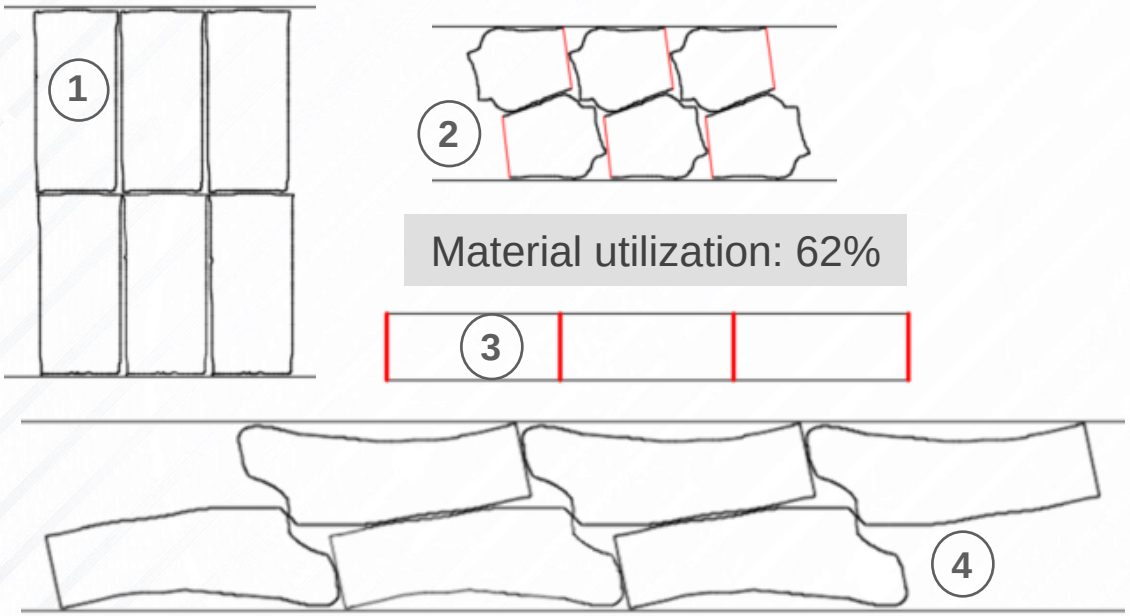
Conventional Multipart Design



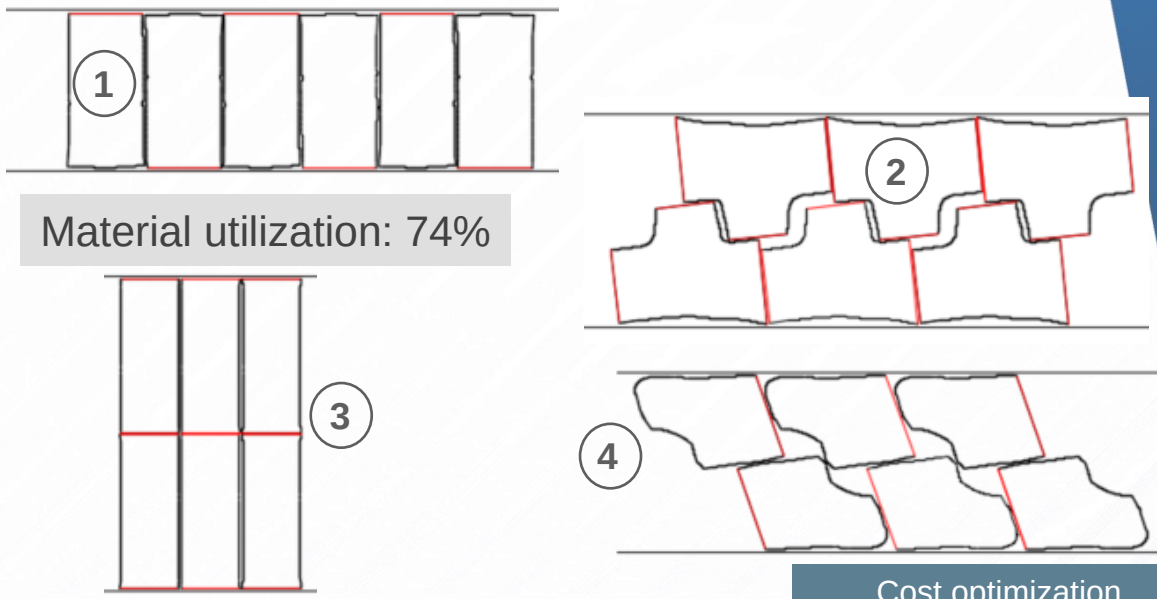
MPI LWB Design



PHS 2000
PHS 1000
PHS 1500
AHSS 600



Material utilization: 62%



Material utilization: 74%

Cost optimization

Part integration

Commonality & modularity

Weight Reduction

Design Feasibility

Crash management

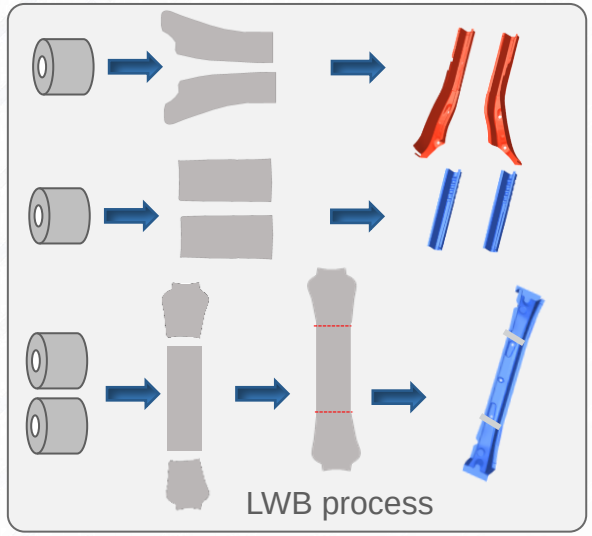
CO_2 emission reduction

REAR RAIL MPI CONCEPT

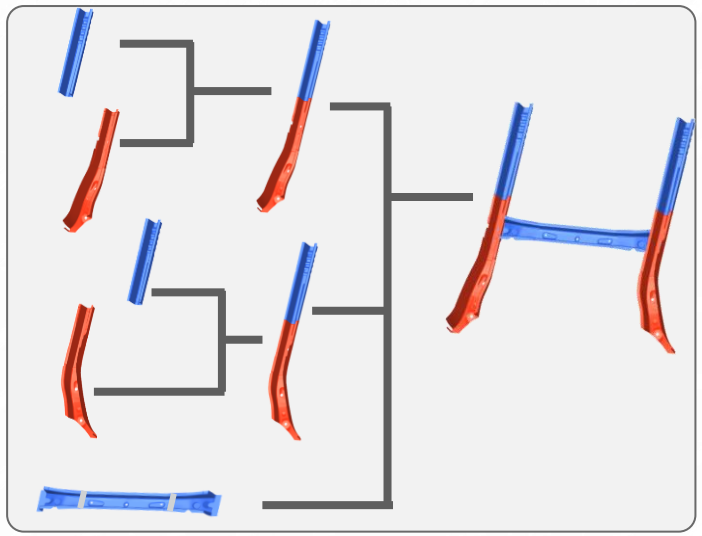
COST OPTIMIZATION

Conventional Multipart Design

Tier suppliers

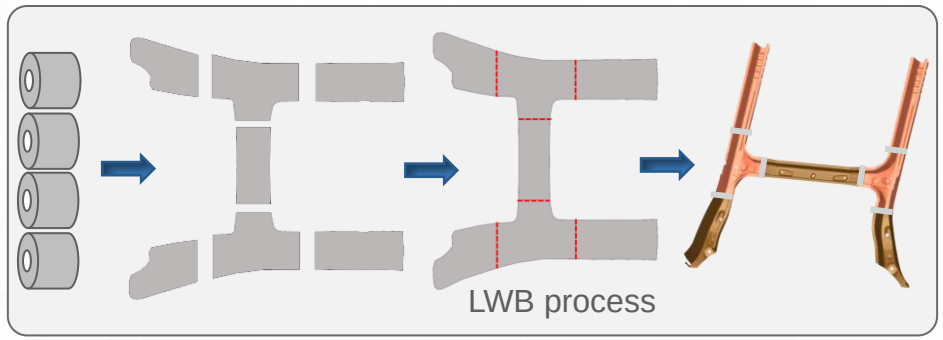


OEM Sub Assembly

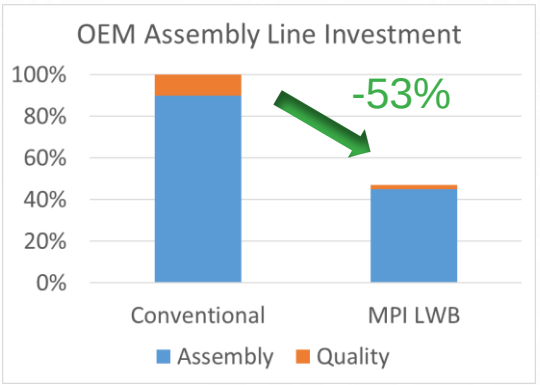


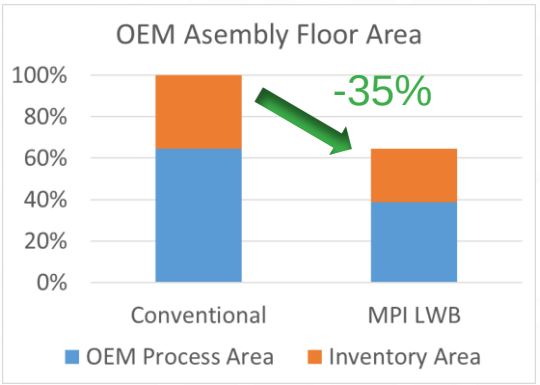
MPI LWB Design

Tier suppliers



OEM Assembly





Reduction of Body shop complexity

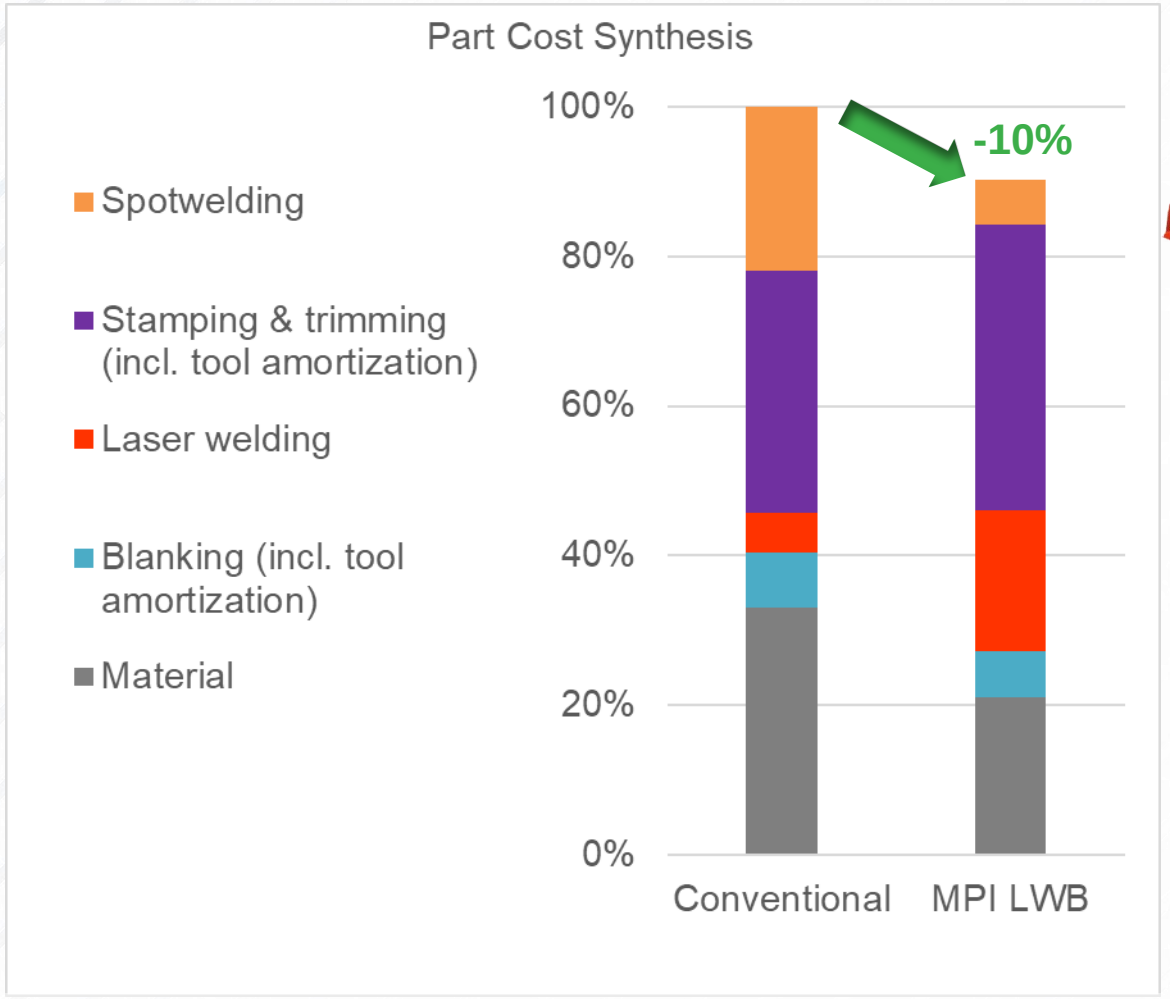
- One stamping tool
- One stamping operation
- One assembly operation
- Fewer logistics steps

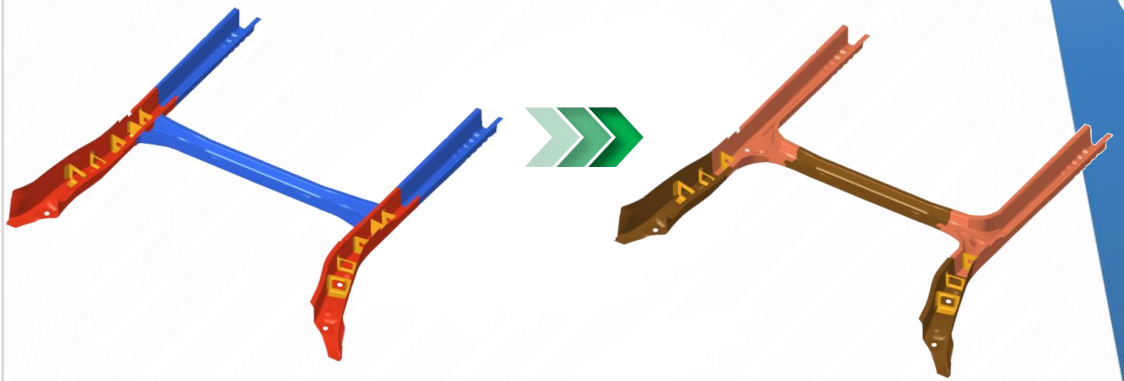
Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | Crash management | CO_2 emission reduction

Cost optimization

REAR RAIL MPI CONCEPT

COST OPTIMIZATION





- Rear Rail MPI - **10%** cost reduction
  - Equivalent crash performance
  - Weight savings - **2.68 kg/vehicle**
- Cost savings achieved through:
  - Elimination of overlaps and reinforcements
  - Reduced material usage
  - No sub-assembly cost
- Assumed volume of 200,000 vehicles per year

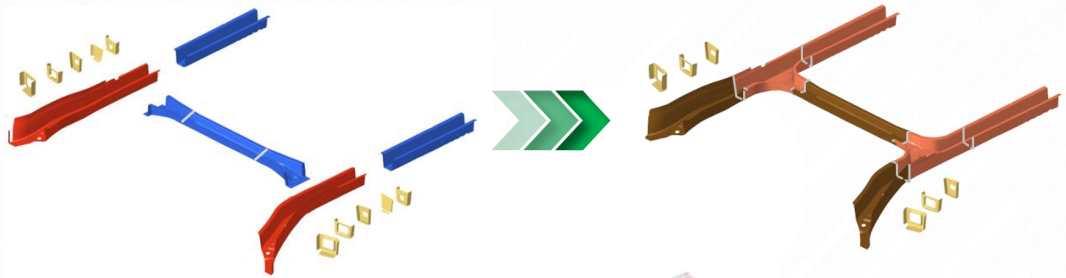
PHS 2000
PHS 1000
PHS 1500
AHSS 600
HSS 350

Part integration | Commonality & modularity | Weight Reduction | Design Feasibility | Crash management | CO_2 emission reduction | **Cost optimization**

CONCLUSIONS

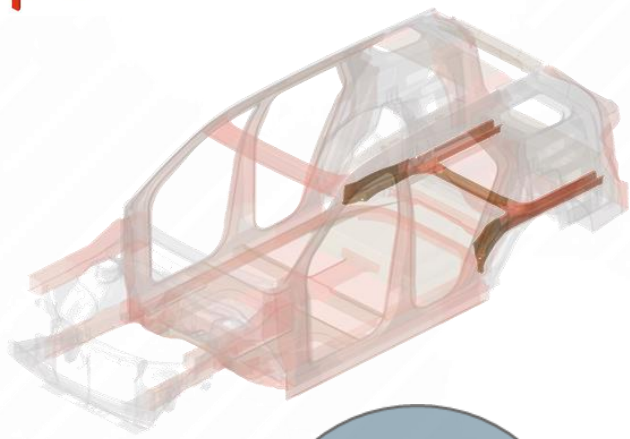
Part integration

Combine **5 parts into 1 MPI LWB**
Eliminated 4 reinforcements



Commonality & modularity

Compatible design with scalable platforms



Weight Reduction

Assembly weight **reduced by 24%**

Design Feasibility

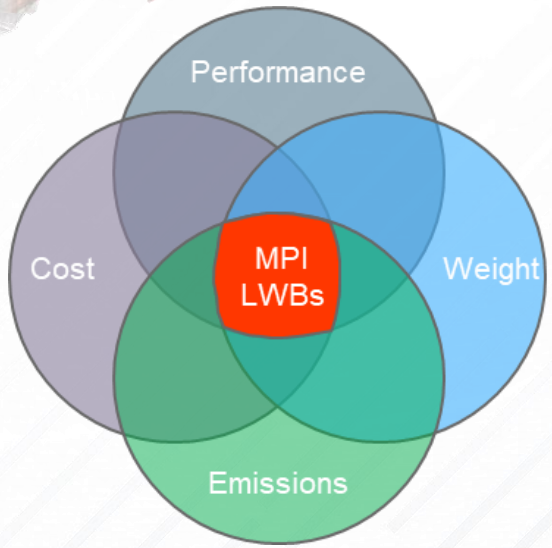
Validated for forming feasibility

Crash management

Equivalent performance for NA/EU safety requirements

CO_2 emission reduction

33.22 kg CO_2 eq saving per vehicle



Cost optimization

Assembly cost **reduced by 10%**
53% OEM investment reduction
35% shop floor space reduction

FOR MORE INFORMATION

Visit our booth!

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25TH ANNIVERSARY

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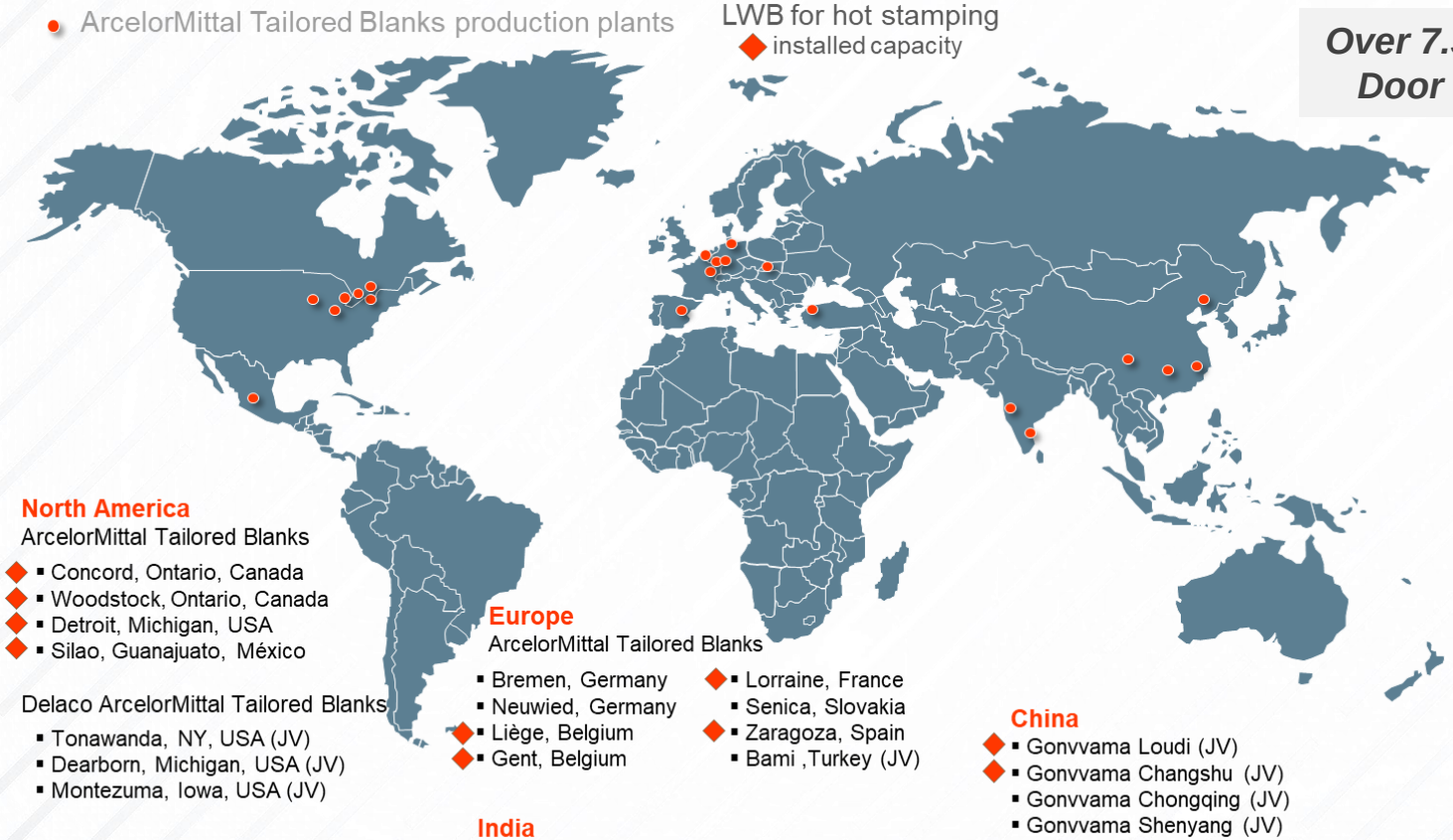
Driving a safer and greener tomorrow



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- Silao, Guanajuato, México

Delaco ArcelorMittal Tailored Blanks
- Tonawanda, NY, USA (JV)
- Dearborn, Michigan, USA (JV)
- Montezuma, Iowa, USA (JV)

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- Neuwied, Germany
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- Gent, Belgium
- Lorraine, France
- Senica, Slovakia
- Zaragoza, Spain
- Bami ,Turkey (JV)

China
- Gonvvama Loudi (JV)
- Gonvvama Changshu (JV)
- Gonvvama Chongqing (JV)
- Gonvvama Shenyang (JV)

India
- ArcelorMittal Neel Tailored Blank Chennai (JV)
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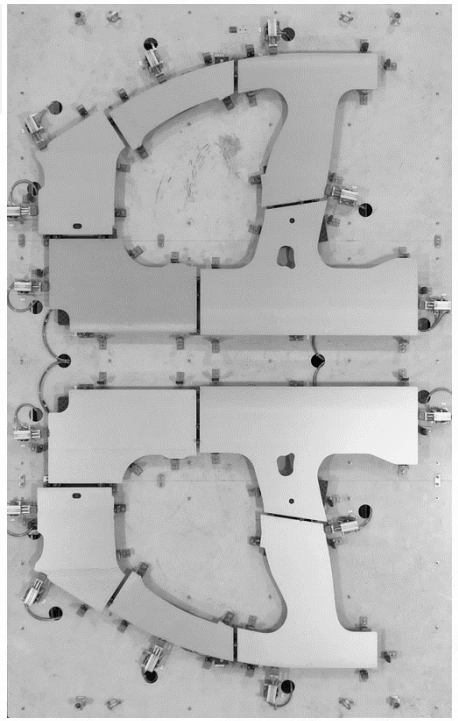
Over 7.3 million HS LWB Door rings produced



Home of the world's most advanced laser welded door ring