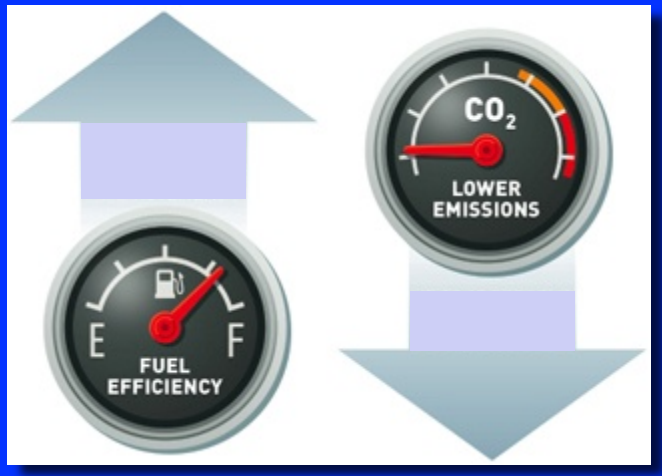
Weight Reduction Opportunities in Automotive Materials



James M. Boileau
Technical Expert, Metallic Materials
Group Leader, Materials Characterization
Research and Innovation Center

Ford

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Disclaimer

Overview

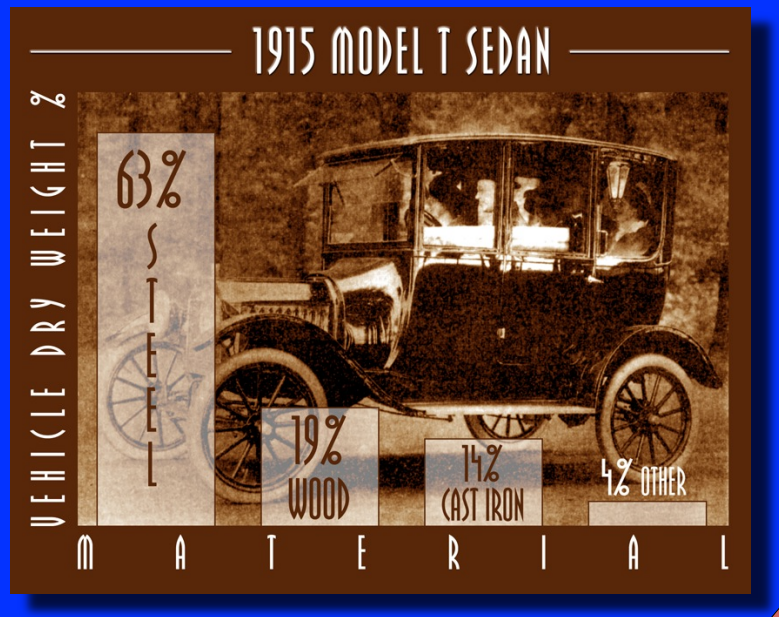
- Drivers for Materials Change
- Background
- Approach
- Lightweight Materials
  - Steels
  - Aluminum
  - Magnesium
  - Polymers & Composites

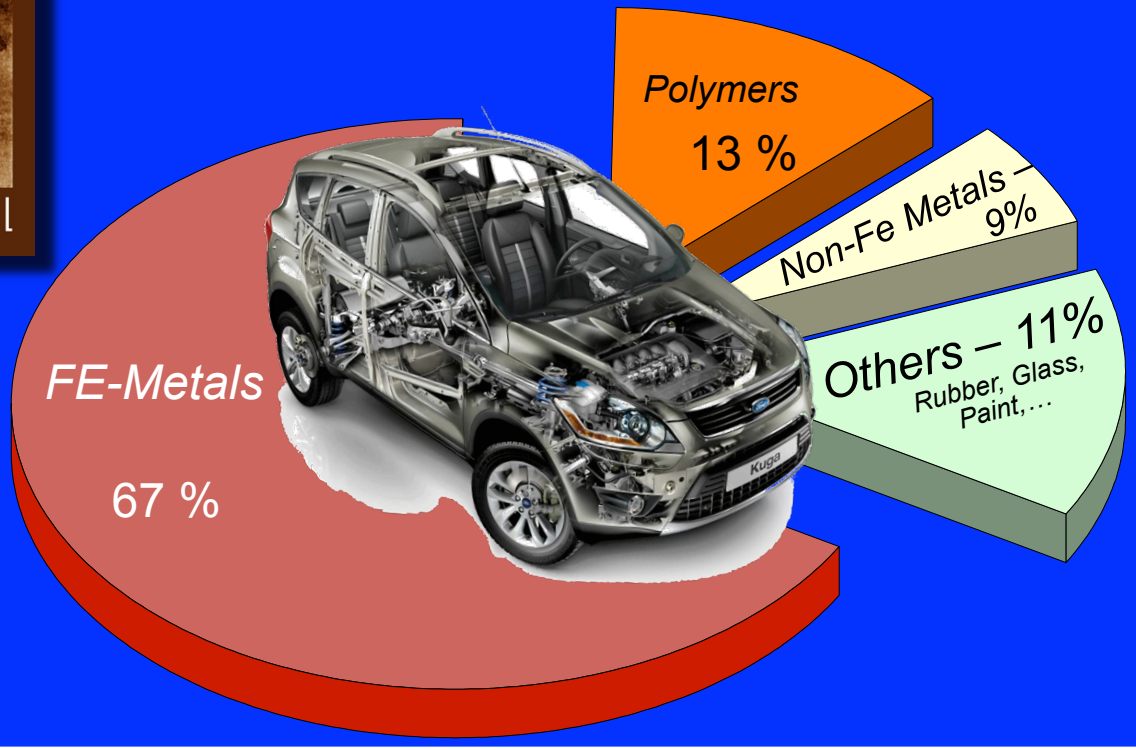
Drivers for Materials Change

- Energy Conservation
- Environment
  - Emissions
    - ✓ CO_2
  - Recycling
- Safety
- Vehicle Electrification

Background

- Materials & Vehicle Weight Over Time -





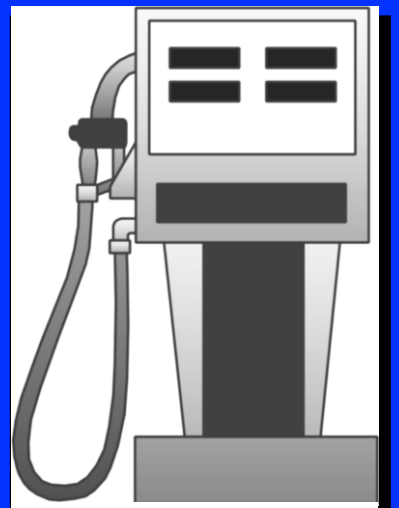
Background

- Vehicle Weight Over Time -

Background

- Regulatory Requirements -

- **US CAFE Standards**
  - Current: 27.5 mpg
  - 2016: 35.0 mpg
- **European Standards**
  - 2016: < 120 g CO_2/km
- **Future**
  - 2025 CAFE: 62.0/56.2/44.0



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Background

- Customer Perceived Vehicle Characteristics -

- Typical Vehicle Road-Test/Rating System
- Weight influences many vehicle attributes
- Weight reduction strategy
  - Part of overall vehicle attribute strategy

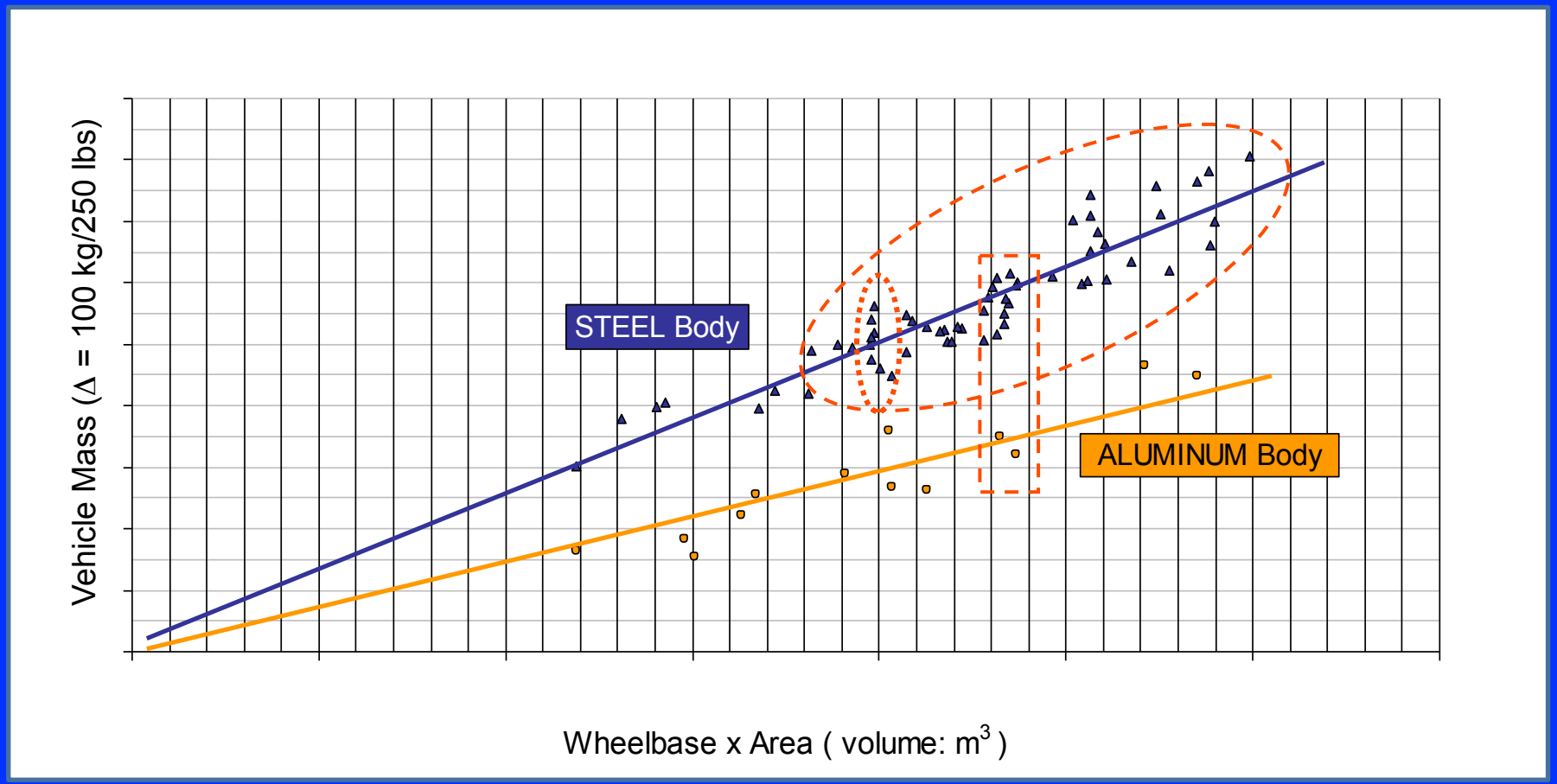
CAR AND DRIVER.com®

✓	Acceleration	8.43
✓	Ride	8.06
	Interior Comfort	7.84
✓	Braking	7.78
✓	Handling	7.58
	Vehicle Styling	7.49
	Dependability	7.41
✓	Fuel Economy	7.29
	Transmission	7.17
	Fit and Finish	6.85

Rating Scale: 1 = Worse 10 = Best

Background

- Vehicle Redesign & Downsizing -



Approach

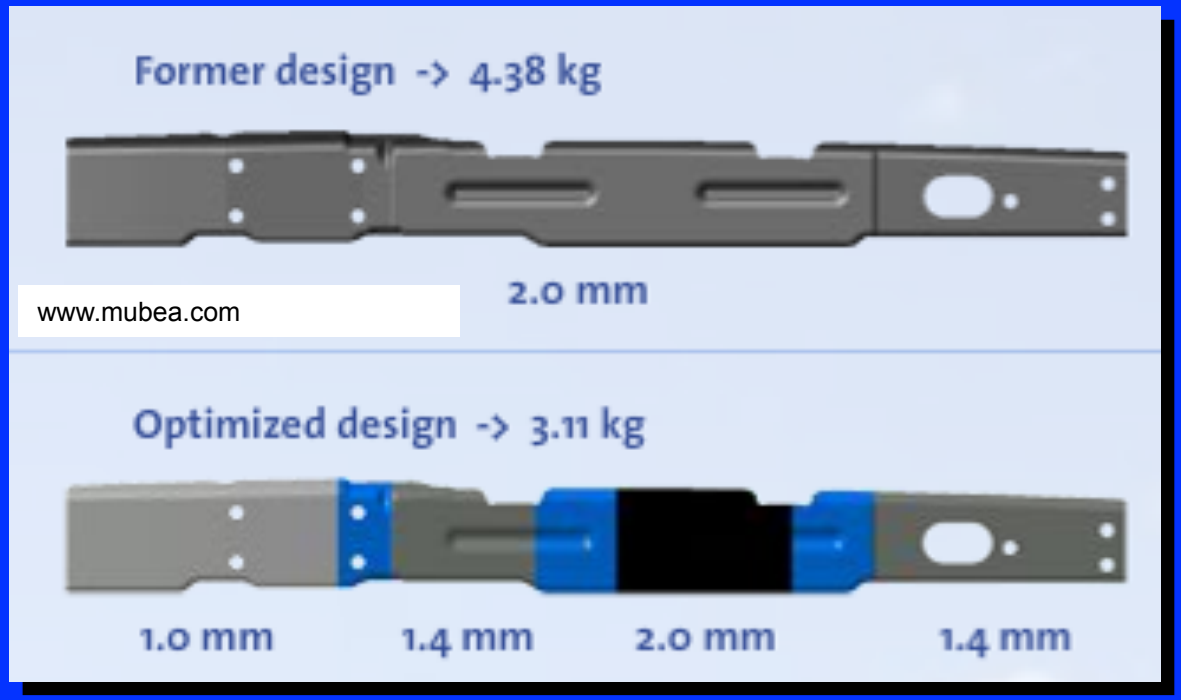
- Enablers for Increased Use of Advanced Lightweight Materials-

- Material substitution using lightweight materials
- Match production volume to specific lightweight material/process
- Reduce manufacturing costs
- Reduce material costs

Approach

- Enablers for Increased Use of Advanced Lightweight Materials-

- "Whole vehicle" optimization using LW material(s)



  - Greater the weight saved → less material required
  - Take advantage of secondary weight savings

Approach

- Primary + Secondary Weight Saving Example -

System	Reduction	
Primary Weight Reduction (Body)	- 430 lbs.	- 12%
Secondary Weight Reductions	- 120 lbs.	- 3%
Powertrain Re-matching (V6 to I4)	- 140 lbs.	- 4%
Total	- 690 lbs.	- 19%

Materials for Weight Reduction

- Key Focus Areas-

Body Structures (25%)
Near Term: AHSS, Aluminum
Future Possibilities: Magnesium, Carbon Fiber Composites

Glazing (3%)
Near Term: Polycarbonate
Future Possibilities – Eng'd Polymers

Interior Structures (14%)
Near Term: AHSS, Al
Future Possibilities: Mg, Biopolymers & Composites

Powertrain (25%)
Near Term : Al
Future Possibilities – Mg, Ti, & High Temp Eng'd Polymers

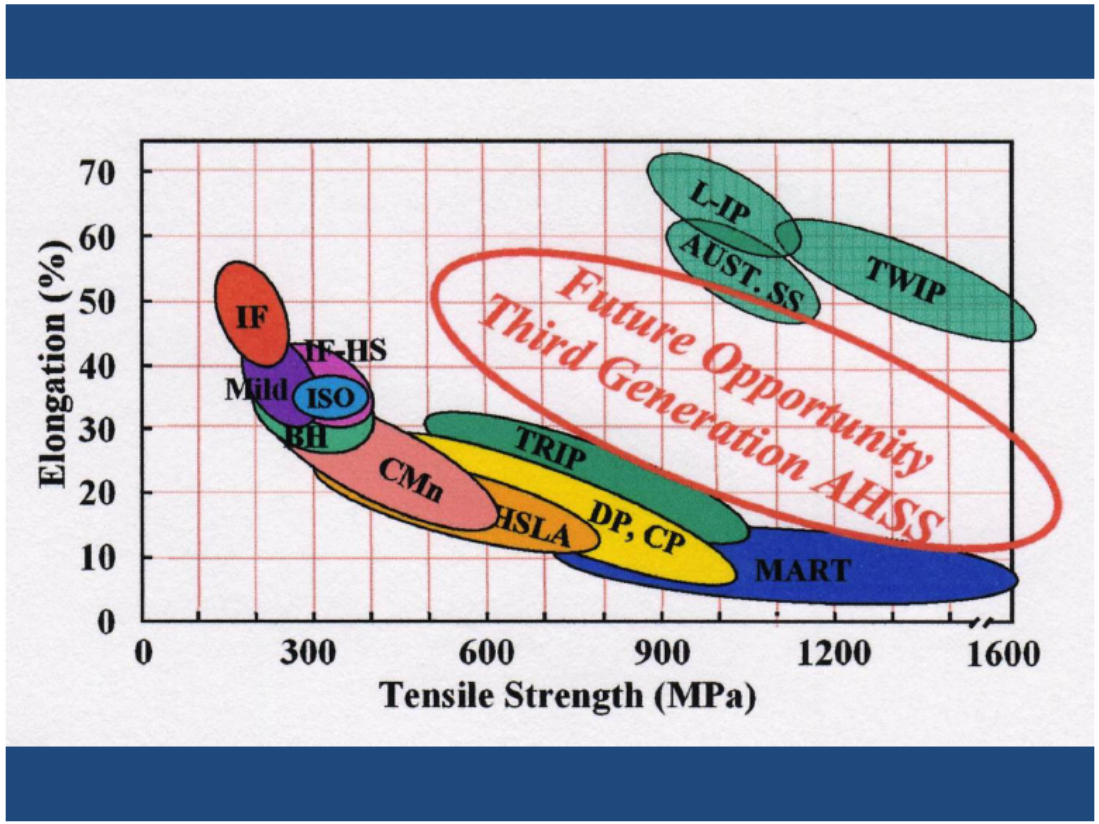
Closures (8%)
Near Term – AHSS, Al, Polymer Composites
Future Possibilities – Mg, Biopolymers & Composites

Chassis & Suspension (14%)
Near Term – AHSS, Al
Future Possibilities – Mg, CF

Materials for Weight Reduction

- Steel -

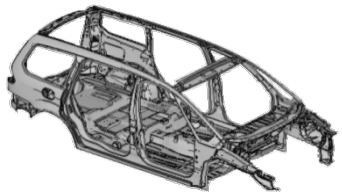
- **Advanced High Strength Steels**
  - Wide Range of:
    - Alloys
    - Properties
    - Availability
    - Cost
  - Design flexibility is high



Materials for Weight Reduction

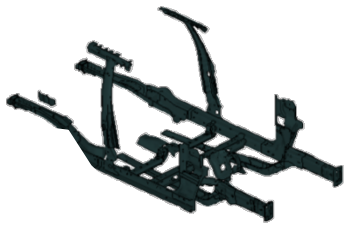
- Steel -

- **Advanced/Ultra-High Strength Steels**
  - **Most mature technology**
  - **Lowest cost alternative**
  - **Weight Savings Potential: 7 – 10%**



CR/HSLA (180–250 MPa)

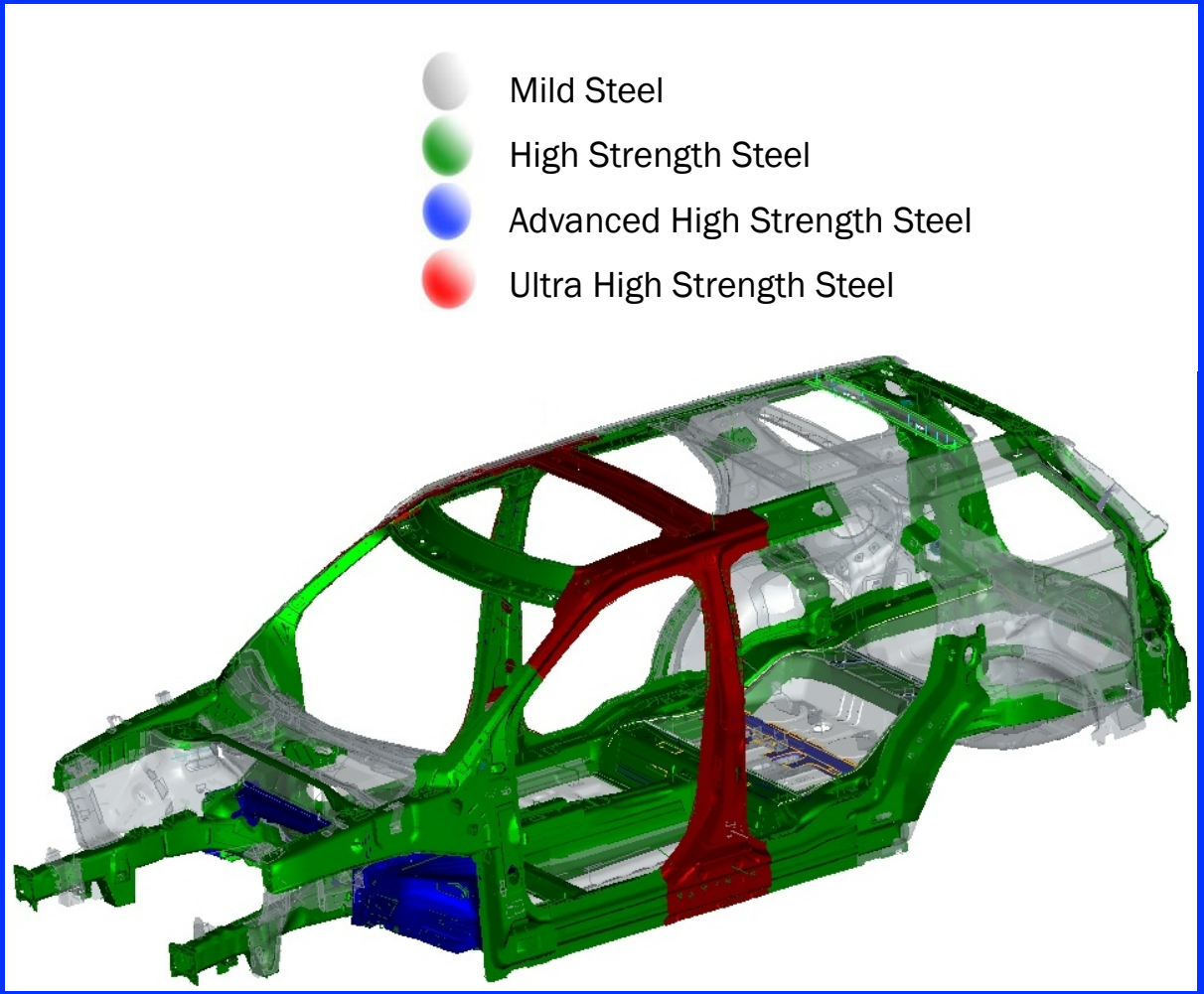
AHSS (250-980 MPa)



UHSS (> 1000 MPa)

Materials for Weight Reduction

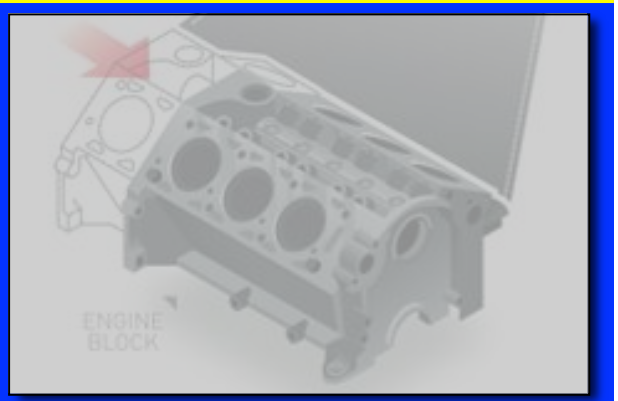
- Steel -



Materials for Weight Reduction

- Aluminum -

- **Aluminum**
  - **Castings**
    - Mature technology for Powertrains
  - **Sheet Aluminum**
    - Closures
    - Limited experience with full-vehicle production
    - Sheet Al material cost
- **Weight Savings Potential: 40 – 50%**



Materials for Weight Reduction

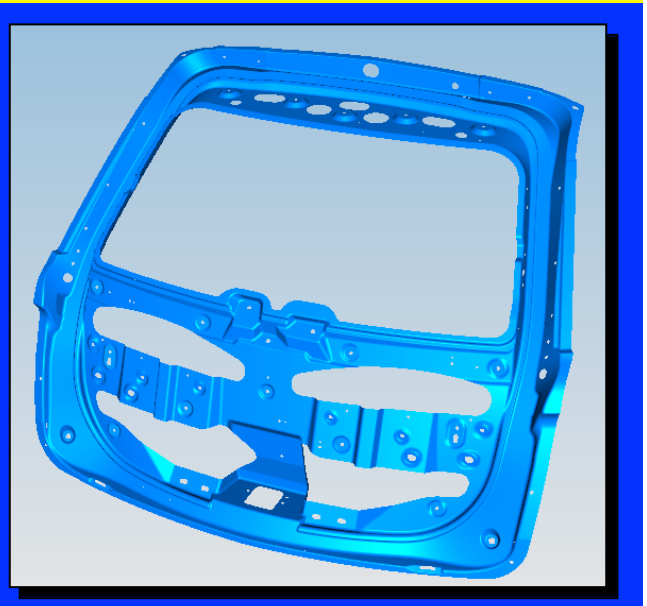
- Aluminum -

- **Sheet Aluminum**
  - **Maturing Technology**
    - All-Al vehicles
    - Knowledge exists
    - New automotive-specific alloys & technologies
  - **Technical Challenges**
    - High-volume NA supply base
    - Repair infrastructure
    - Sorted scrap for recycling

Materials for Weight Reduction

- Magnesium -

- **Magnesium**
  - **Weight Savings Potential: 50 – 60%**
  - **Current Vehicle Usage: <1%**
  - **Issues**
    - Economic
    - Technical
  - **Projected 2020 Usage:**
    - Slight increase



Materials for Weight Reduction

- Polymers & Composites -

- **Composites**
  - **Weight Savings Potential: 10 – 60%**
  - **Polycarbonate**
    - 40% Savings
    - Design Flexibility
  - **Structural/High Temperature Applications**
  - **Issues**
    - Economic
    - Technical

Summary

- Vehicle Materials -