Trends in Automotive - Aluminum

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The Aluminum Association's Transportation Group (ATG)

OPC Meeting
July 16, 2013
Ann Arbor, MI

Aluminum Transportation Group (ATG)

Discussion Outline

Why Are We Here?

Aluminum - long term automotive growth

Automakers to double use of aluminum by 2025

Mass reduction is key to improving vehicle fuel economy.

Changing Vehicle Make-up

Demand Drivers

Why Light Weighting? / Role of Aluminum

Studies | Mass Reduction (Materials Perspective)

FEV/EDAG Venza – MMV

EDAG Venza – AIV

Outside Processor Opportunities - Aluminum

Q & A

Mass Reduction | Part of the Solution

VALUE PROPOSITION (*Varied by OEM and platform)*

- **Fuel Economy**

  Consumer demand

  CAFE

- Mass reduction vs. acceleration (powertrain selection)
- Weight balance (50/50 or C of G or Yaw moment)
- Inertia class
- Enabling of low stored energy, or hybrid vehicles

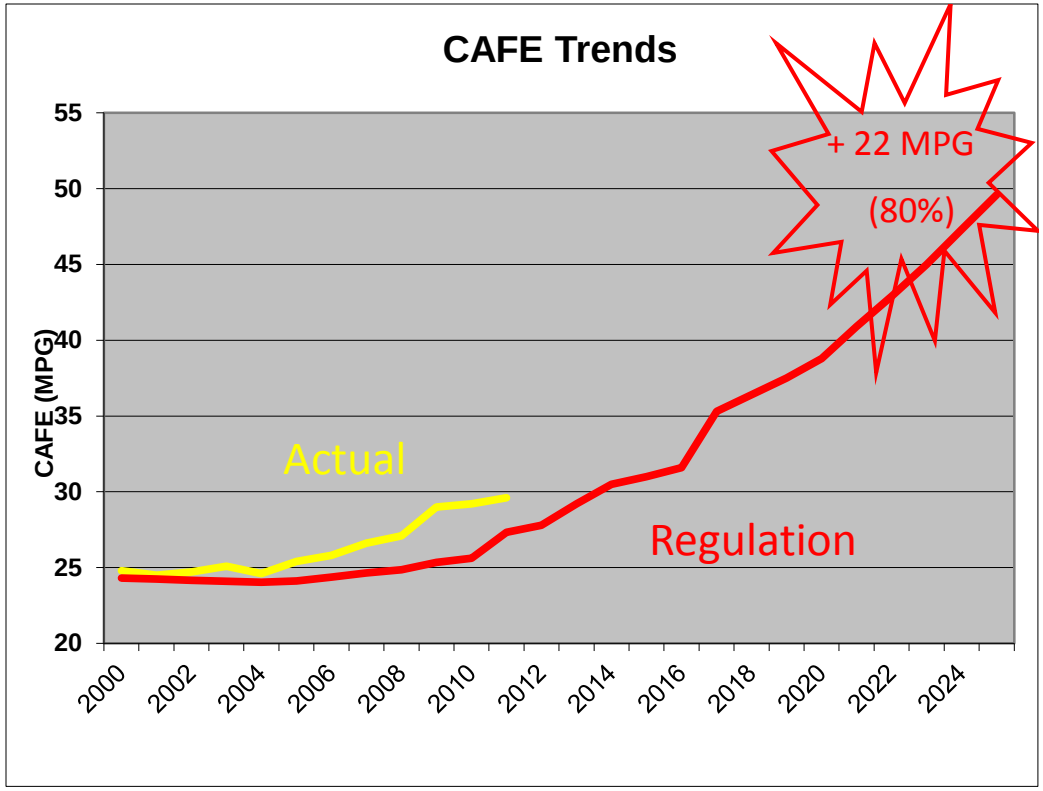
Mass Reduction | Part of the Solution

CAFE 2017-25 Regulation

54.5 MPGe (equivalent)
credits (7 – 9 MPG)
47 MPG (pre-credits)

Weight reduction assumption
overcame safety concerns
400 Lbs. avg. (10-20%)
achieves 2-3 MPG gain

Maintained “Footprint “ basis

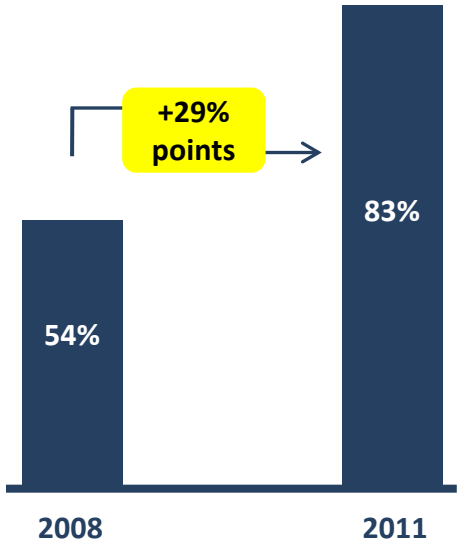


Consumers Driving Improvements

Buyer Behavior

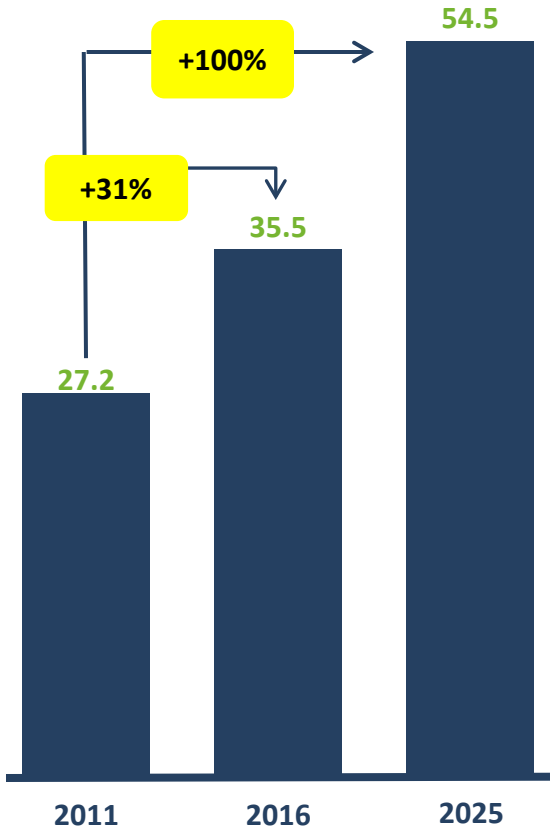
Percentage of consumers willing to pay more for fuel-efficiency

65% of consumers:
Fuel Economy is the #1 factor in buying decision!



Regulation Change

US Corporate Average Fuel Economy (MPG)



40 Years of Uninterrupted Aluminum Growth

Sources: Consumer Reports, Ducker Worldwide 2011, Aluminum Association, Alcoa analysis

Weight Reduction = ↑ Fuel Economy

	Fuel Economy Improvement / 10% Weight Reduction (EPA Combined Drive Cycle)			
	Passenger Vehicle		Truck	
	Base Engine	Downsized Engine	Base Engine	Downsized Engine
Gasoline	3.3 %	6.5 %	3.5 %	4.7 %
Diesel	3.9 %	6.3%	3.6 %	4.7 %
PEV	6.3 % *		5.7 % *	
PHEV	6.3 % *		5.7 % *	

* - Power consumption

Source: Ricardo Consulting Engineers

Automotive Mass Reduction Facts
(Independent of Material Choice)

- **Achieving 2025 objectives will take all available technologies**
  - Powertrain
  - Mass
  - Aero
  - Rolling resistance
- **Mass reduction additive to other FE improvements**
  - Including: Diesel, Hybrid, Electric, Aero, Tires…
- **10% vehicle mass reduction = 6.5% fuel economy improvement**
- **Significant gains achievable (+ 1.5 – 5.0 MPG @ 45 MPG)**
- **OEM's: "Mass reduction critical to achieving 2025 objectives"**

TRANSPORTATION CONSTRUCTION INDUSTRIAL MATERIALS FINANCIAL

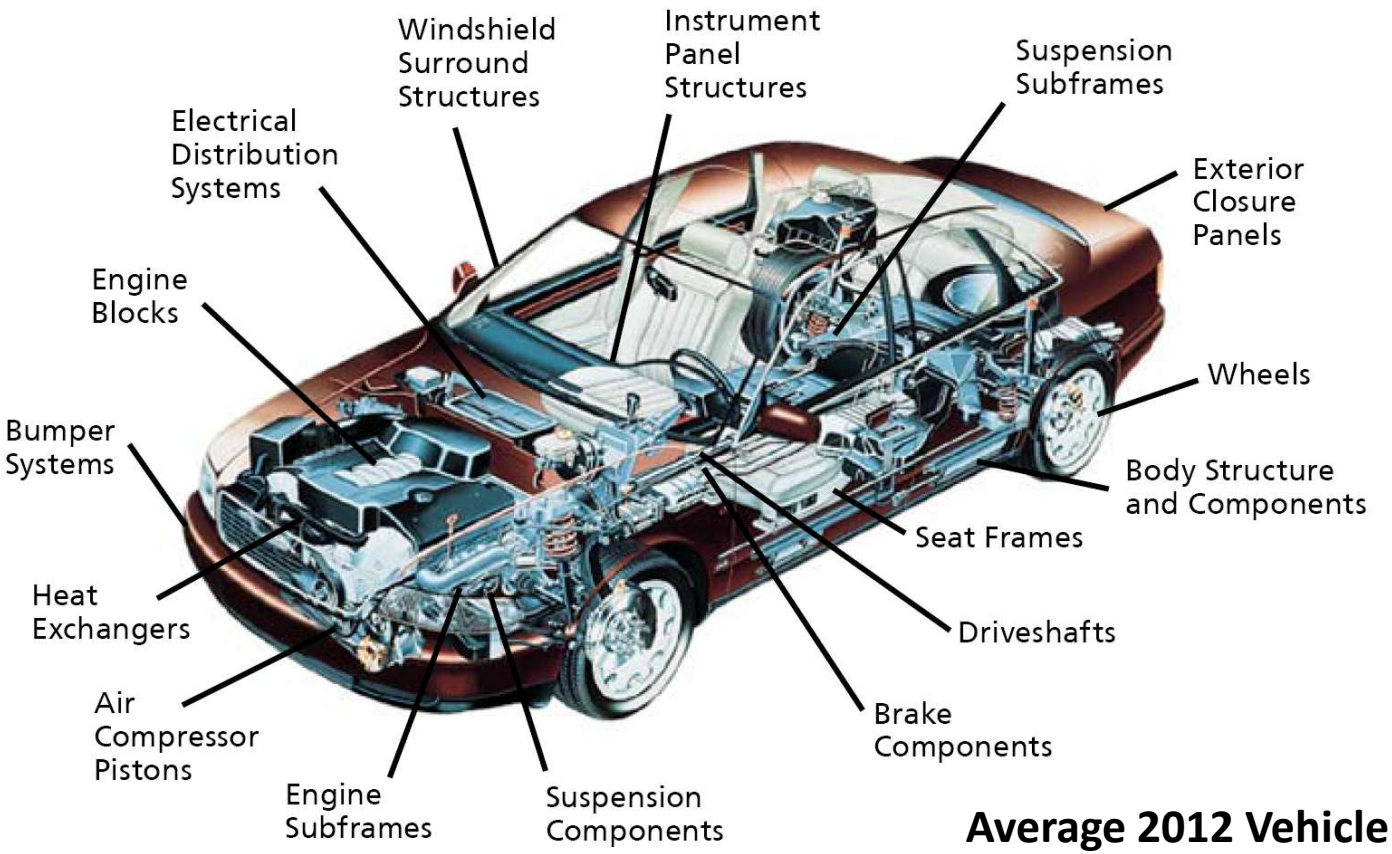
Aluminum Association
Aluminum in 2012 North American Light Vehicles

Executive Summary

DUCKER WORLDWIDE

August 18, 2011

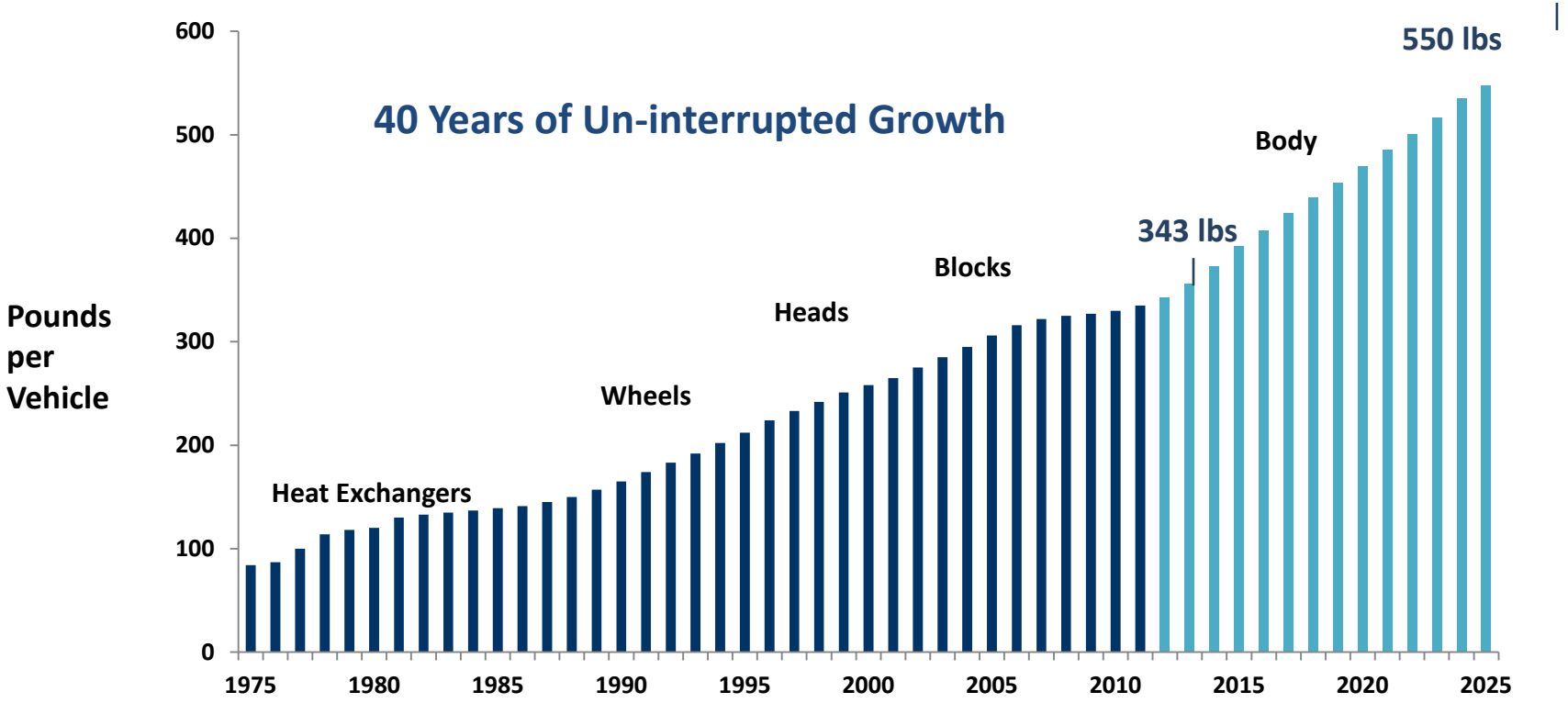
Automotive Aluminum Today



Average 2012 Vehicle:
343 Lbs. (9%) Aluminum

Source: Ducker Worldwide 2011

Aluminum Use in Vehicles Accelerating



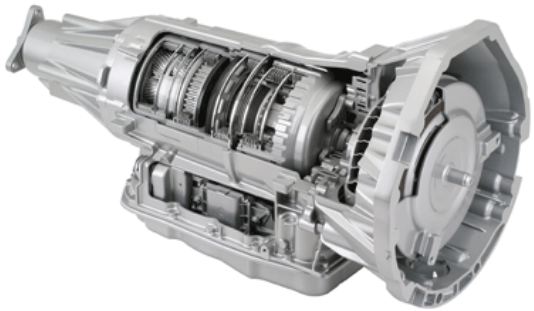
Source: Ducker Worldwide 2011

Nearly 90% of aluminum content is in these four components -

Heat Exchangers

Engines

Transmissions

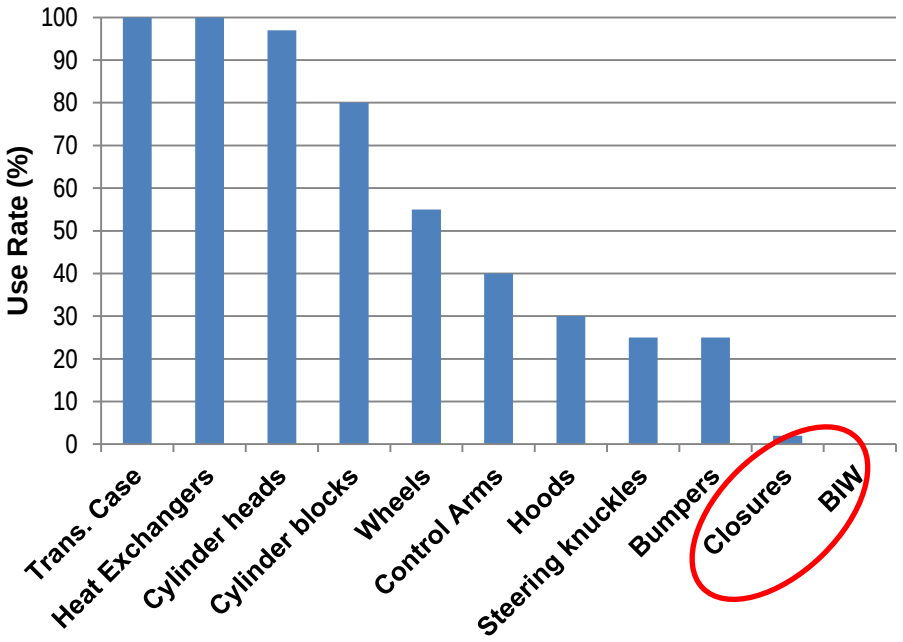


Wheels

Source: Ducker Worldwide 2011

Body - Largest Remaining Mass Reduction Opportunity

- **Aluminum penetration continues**
- **Potential future mass savings with steel are diminishing**
  - Advanced steels
- **Aluminum is the logical next step**
  - Al Closures, Steel BIW
  - Al Closures, Steel/Aluminum BIW
  - Al Closures, Aluminum/Steel BIW



Source: Ducker)

By 2017 over 20% of aluminum content –

Body, bumper and closure components

Complete Body Structures

Bumper Beams

Shock Towers

Door and other closure inners

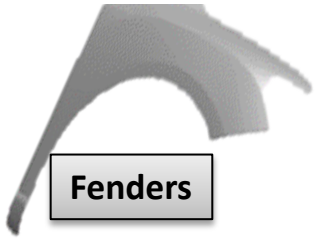
Closures

Deck

Door Outer

Door Outer

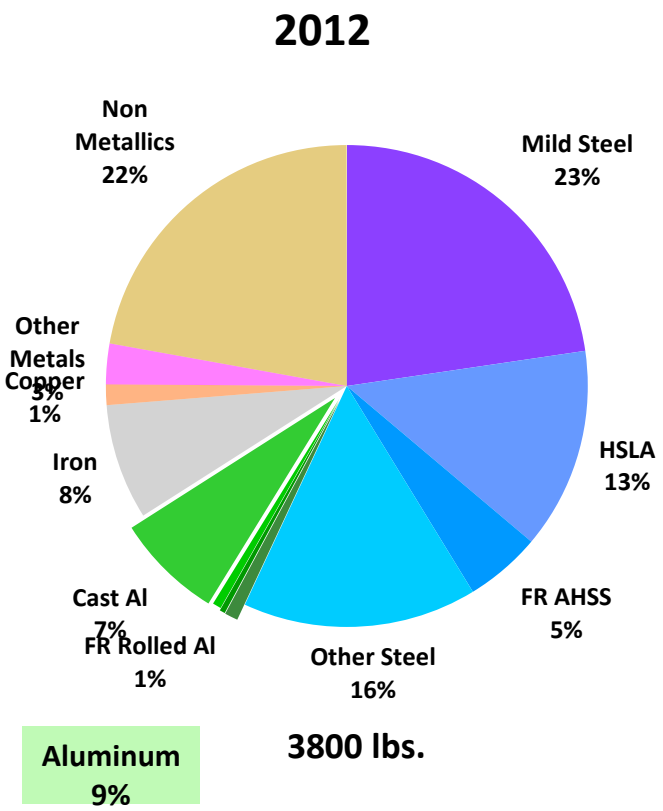
Hood

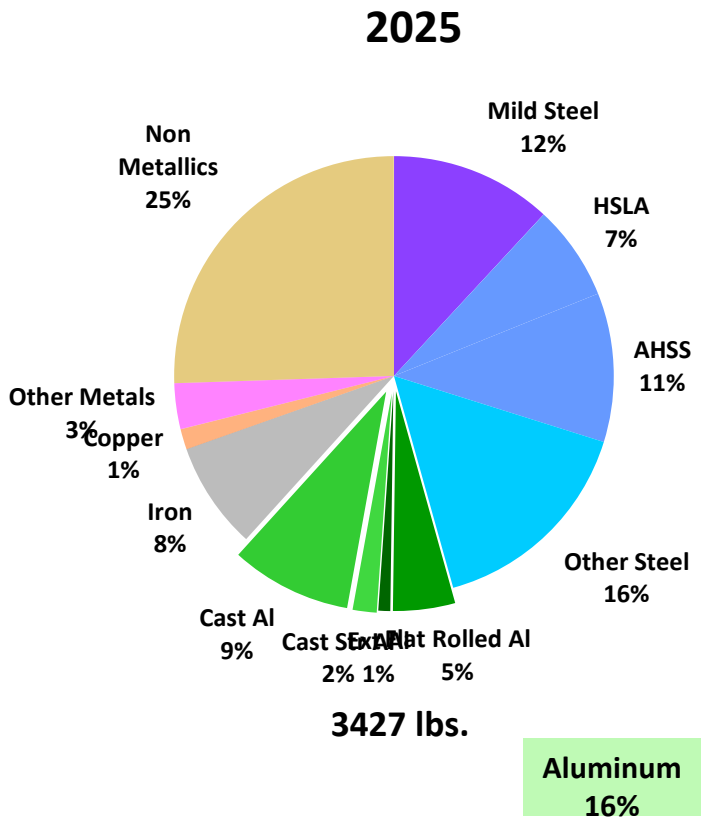


Fenders

Source: Ducker Worldwide 2011

Automotive Material Distribution – 2012:2025





Source: Ducker Worldwide 2011

Aluminum Today

High volume, all aluminum cars and trucks will enter the marketplace

Tesla Model S

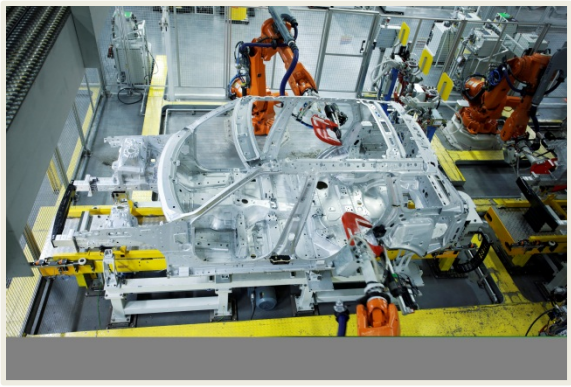
World Car of the Year -
Automobile Magazine's Car of the Year

All-electric vehicle relies on an **all-aluminum body** to save weight, allowing it to **go farther** while producing **zero emissions** and offering **rapid acceleration** and **nimble performance**.

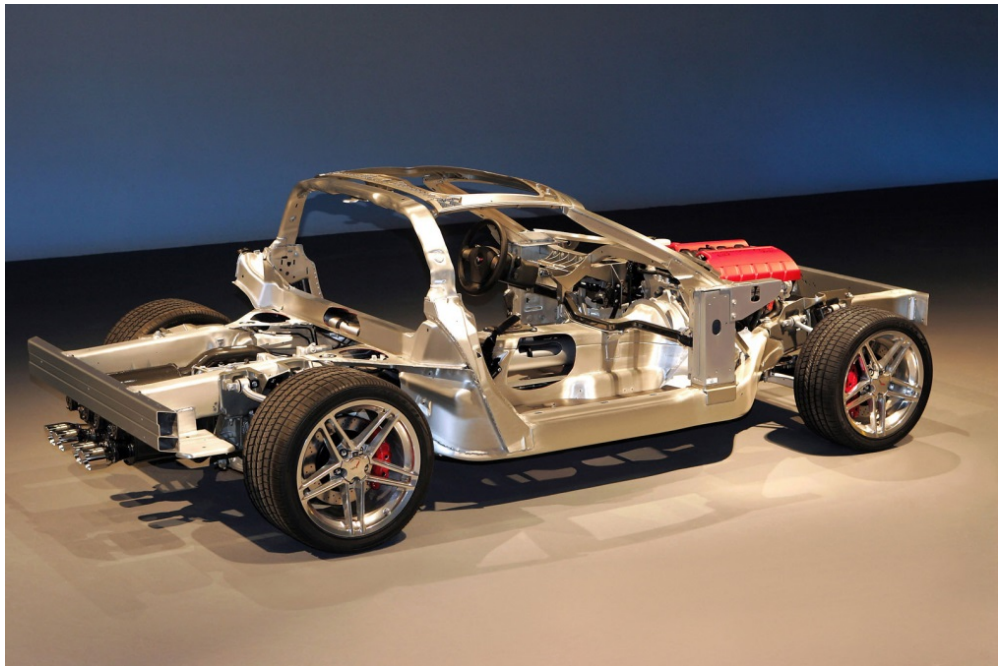
Land Rover Range Rover
World's First All-Aluminum SUV

All-aluminum unibody

- **39 percent lighter than outgoing steel body**
- **Total vehicle weight savings of 926 lbs.**
- **Significant enhancements**
  performance
  agility
  fuel economy
  CO2 emissions

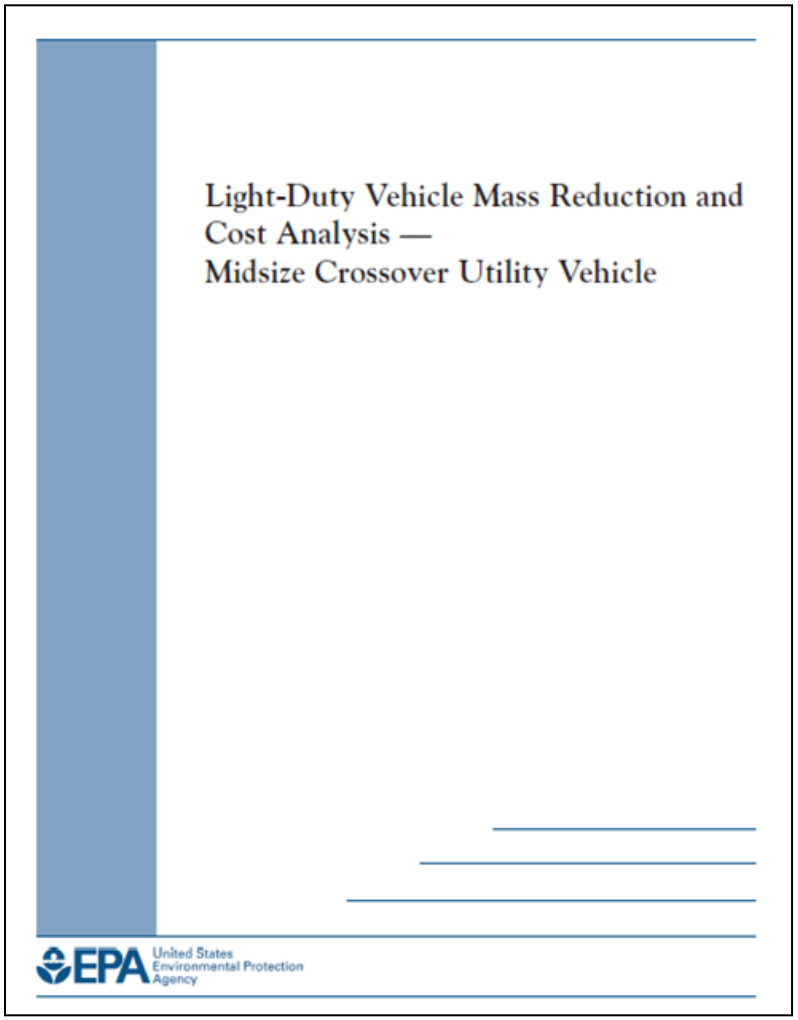


Laser Welding Opportunities – Auto Body Aluminum



EPA Crossover SUV (MMV) Study

"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"



Crossover SUV (MMV) Report

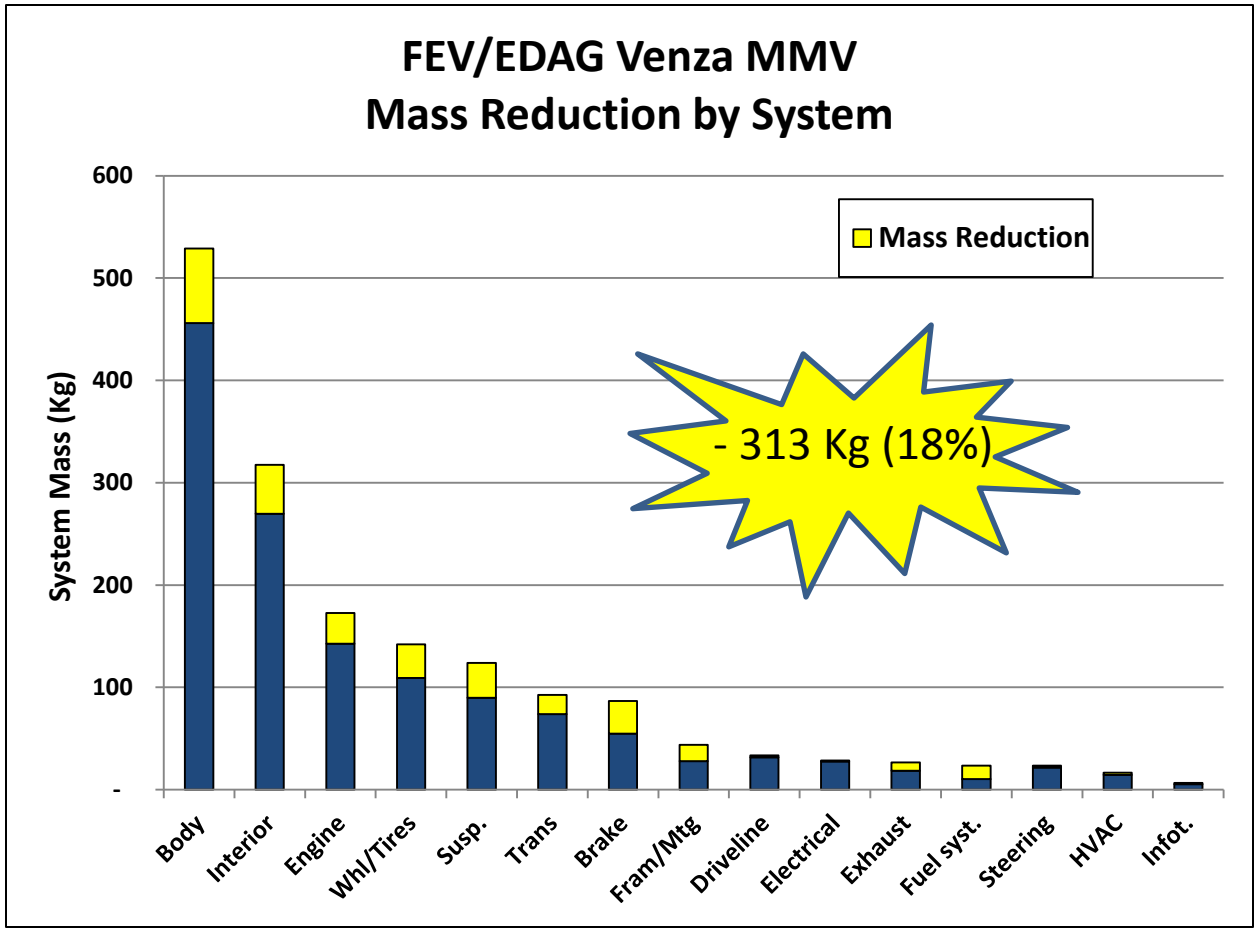
"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"

Objectives:

- **Mass Reduction – 20%**
- **Retain:** **Size**
  Functionality
  Safety (5 Star)
  NVH
  Performance
- **Proven Toyota body structure**
- **Cost increase < 10%**
- **Materials and process <u>available and practical 2017</u>**

***Source**: EDAG*

Crossover SUV (MMV) Mass Reduction



Crossover SUV (MMV)

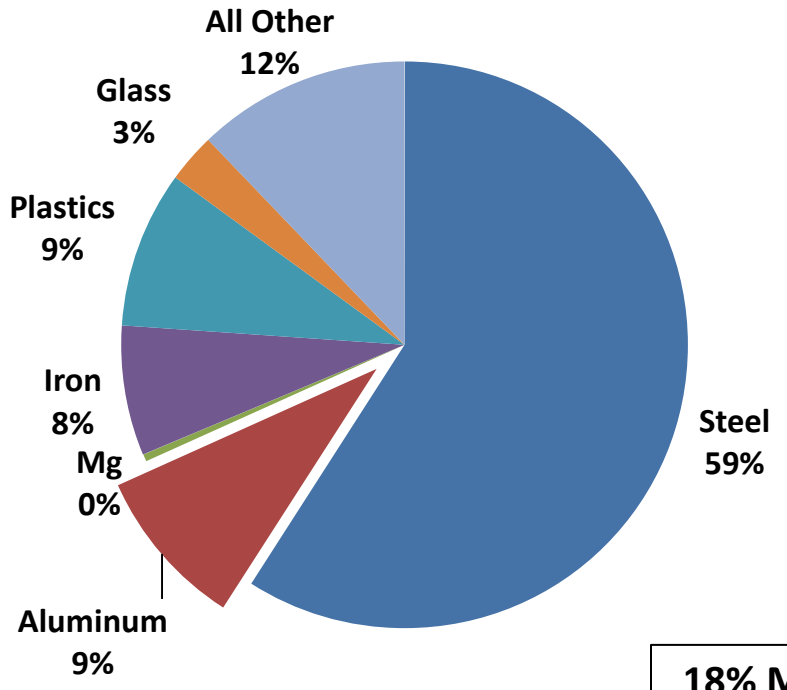
"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"

MASS REDUCTION BY MATERIAL	
Steel (HSS/AHSS) 57% BIW BIW, Bumper, Wheels	54 Kg
Aluminum Closures, Transmission, Arms, Knuckles, Hubs, Calipers	53 Kg
Magnesium Sub-frame, Seating, IP Beam, Engine	37 Kg
Plastics Interior/Exterior trim (MuCell, PolyOne)	38 Kg
Downsizing Engine/Trans, Fluids, Brakes, Exhaust	96 Kg
Design Park Brake, Seats, Trans, Window reg.	35 Kg
TOTAL:	**313 Kg**

Crossover SUV(MMV)

"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"

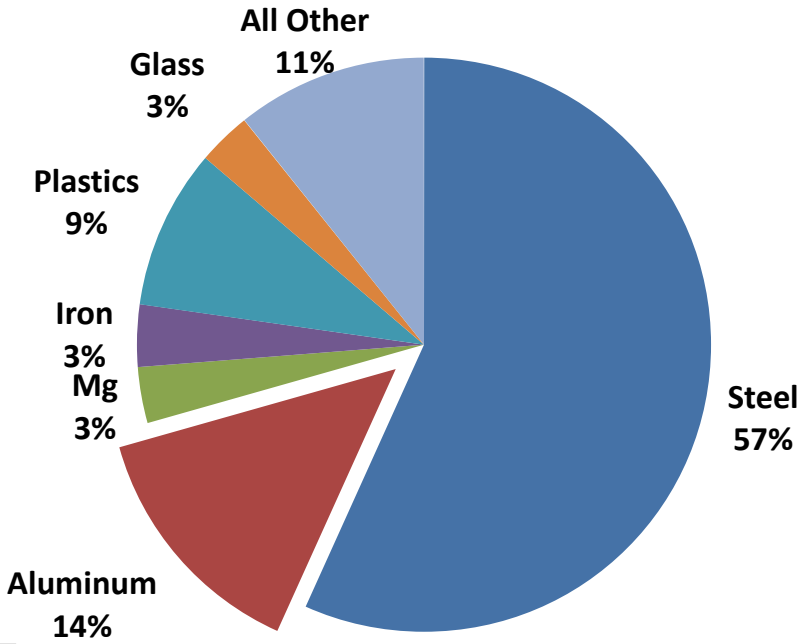
Baseline Venza



Total Mass: 1,711 Kg

18% Mass Reduction

Venza MMV



Total Mass: 1,399 Kg

Source: EDAG/EPA **http://www.epa.gov/otaq/climate/documents/420r12026.pdf**

FEV/EDAG Crossover SUV

"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"

COST

Total LSV cost : $148 **reduction**

Premium costs – HSS/AHSS (BIW), aluminum (closure panels) and magnesium (castings). Offset by mass driven cost reductions in other vehicle systems.

	Mass	Cost	Net $/Kg Reduction
BIW: 50% HSS/Aluminum	-54 Kg	+ $ 136	+ $ 1.69 / Kg
Closures: Aluminum	- 17 Kg	+ $ 91	+ $ 4.71 / Kg
Rest of Vehicle	- 241 Kg	- $ 375	- $ 1.94 / Kg
Total Vehicle	- 313 Kg	- $ 148	- $ 0.47 / Kg

Crossover SUV (MMV)

"Light-Duty Vehicle Mass Reduction and Cost Analysis – Midsize Crossover Utility Vehicle"

FINDINGS

- Reduced mass mid-size sedan can meet all design objectives: size, functionality, safety, NVH, performance
- **18% (313 Kg) mass reduction** – achievable MMV
  - advanced steel – BIW
  - aluminum – closures, chassis, suspension, brakes
  - Magnesium – seats, sub-frame, cradle, IP beam
- **FE impact: +3.1 MPG fuel economy**
  (from 27 to 30.1 MPG)
- Estimated **cost impact: -$148 (reduction)**

AIV Crossover SUV

SUV Aluminum BIW Concept Study

January 23, 2013

AIV Crossover SUV

Objectives:

- **Maximum Practical Mass Reduction – <u>Aluminum Intensive Body</u>**
- **Retain:** **Size**
  Functionality
  Safety (5 Star)
  NVH
  Performance
- **Proven Toyota body structure**
- **Cost increase: TBD**

- **Materials and process <u>available and practical 2017</u>**

***Source**: EDAG*

AIV Crossover SUV Body

AIV Body Mass Reductions			
	Baseline	AIV	Reduction
BIW	378 Kg	220 Kg	162 Kg
Doors	96 Kg	67 Kg	28 Kg
Hood	18 Kg	10 Kg	8 Kg
Hatch	15 Kg	8 Kg	7 Kg
Fenders	7 Kg	5 Kg	2 Kg
TOTAL	**514 Kg**	**310 Kg**	**208 kg *(40 %)***

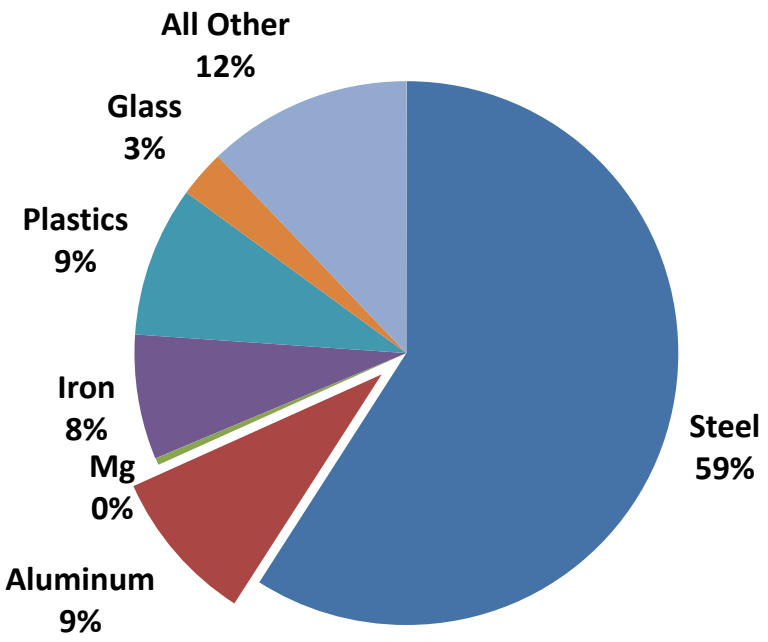
Source: EDAG/ATG

AIV Crossover SUV – Materials Summary

MASS REDUCTION BY MATERIAL With FEV/EDAG LW Venza non-body content	
Aluminum BIW, Closures, Cradle, Sub-frame, Knuckles, Calipers	242 Kg
Magnesium Sub-frame, Seating, IP Beam, Engine	37 Kg
Plastics Interior/Exterior trim (MuCell, PolyOne)	38 Kg
Downsizing Engine/Trans, Fluids, Brakes, Exhaust	117 Kg
Design Park Brake, Seats, Trans, Window reg.	35 Kg
TOTAL:	**476 Kg**

AIV Crossover SUV Materials

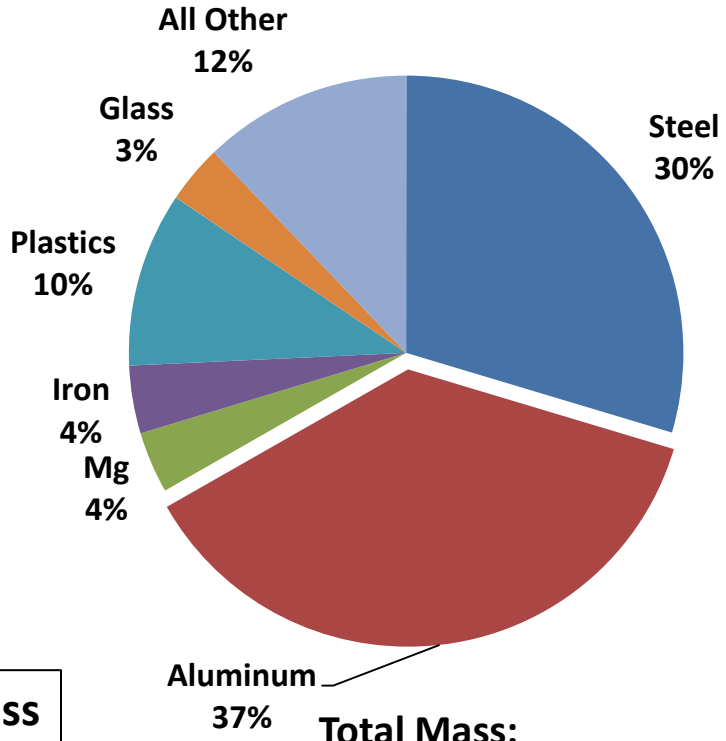
Baseline SUV



Total Mass:
1,711Kg

28% Mass Reduction

AIV SUV



Total Mass:
1,237 Kg

AIV Crossover SUV – Mass Reductions

COST

Total AIV cost increase: $534

Premium costs – Aluminum (BIW, closure panels) and magnesium (castings). Partially offset by mass driven cost reductions in other vehicle systems.

	Mass	Cost	Net $/Kg Reduction
BIW: Aluminum	- 162 Kg	+ $ 789	+ $ 4.87 / Kg
Closures: Aluminum	- 44 Kg	+ $ 135	+ $ 3.06 / Kg
Rest of Vehicle	- 263 Kg	- $ 389	- $ 1.81 / Kg
Total Vehicle	- 476 Kg	+ $ 534	+ $ 1.12 / Kg

AIV Crossover SUV – Findings

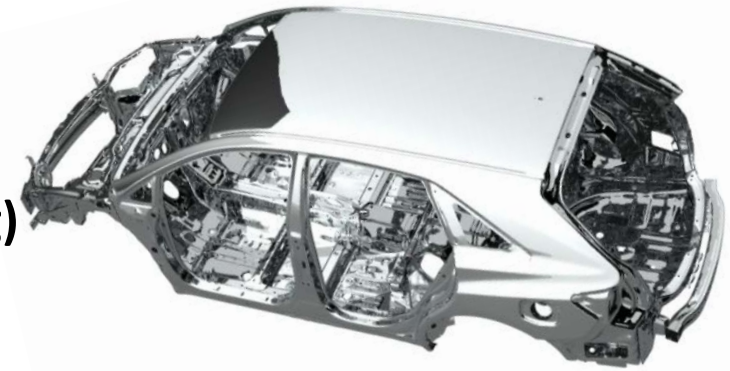
FINDINGS

- Aluminum intensive mid-size cross-over SUV can meet all design objectives: size, functionality, safety, NVH, performance

- **28% (476 Kg) total mass reduction** – achievable MMV
  - aluminum – BIW, closures, chassis, suspension, brakes

- FE impact: **+4.8 MPG fuel economy**
  (from 27 to 31.8 MPG)

- Estimated **cost impact: +$534 ($1.12/Kg)**

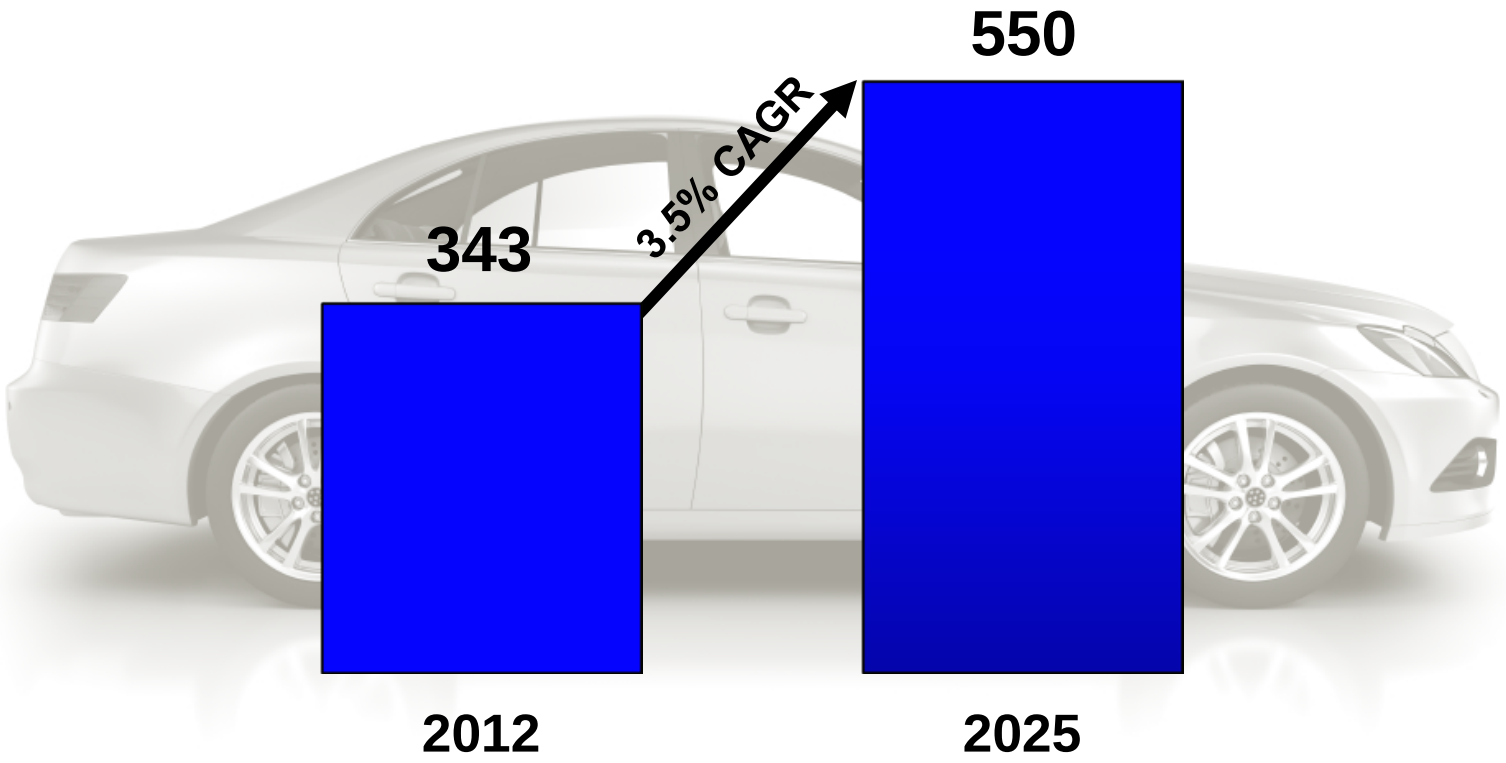


Emerging Opportunities – Auto Aluminum

Market Needs / OSP Opportunities

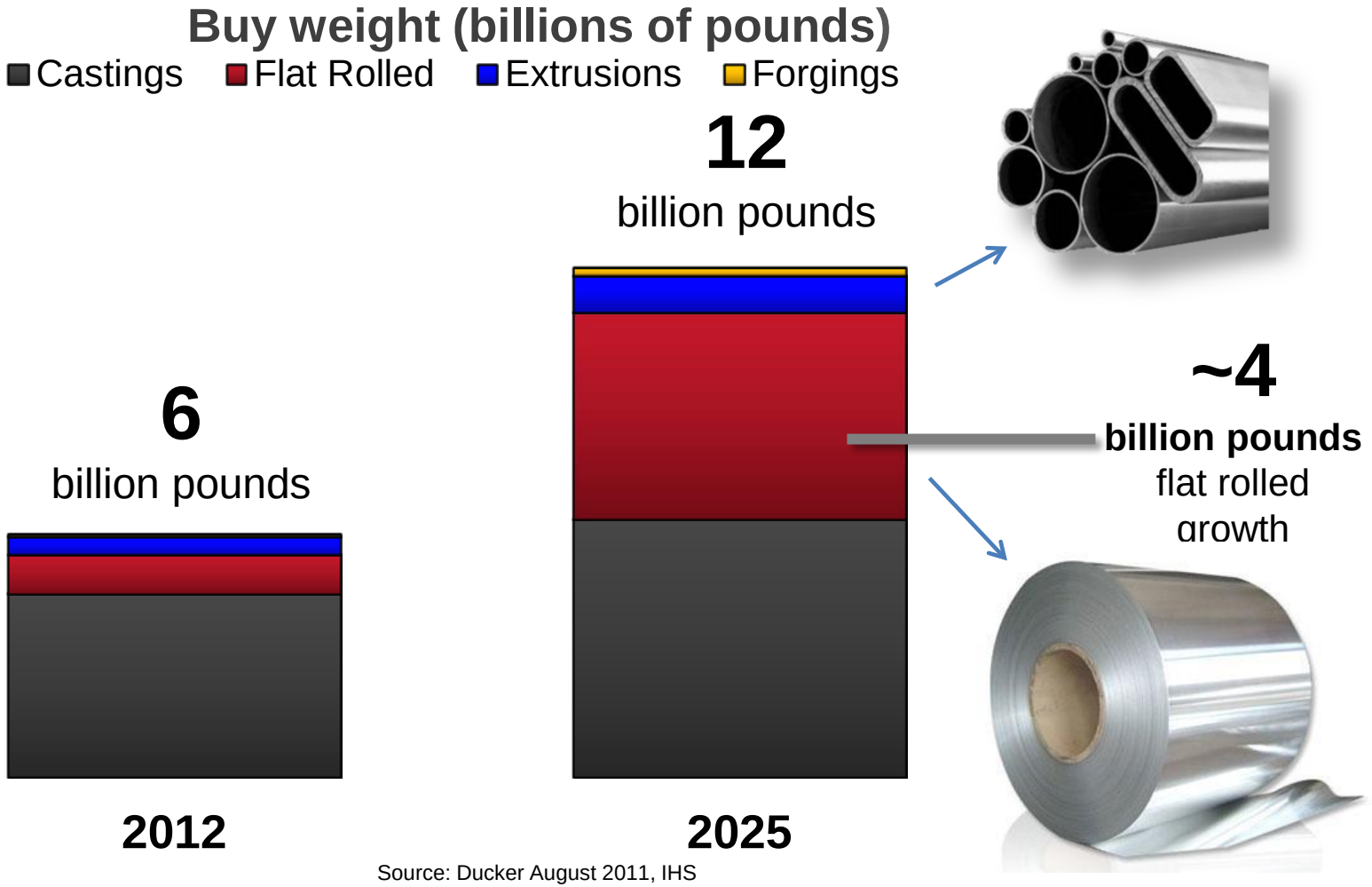
-- Capable aluminum processors needed --

Automotive aluminum content is expected to increase ~60% by 2025



Source: Ducker August 2011, Aluminum Association Transportation Group

Aluminum cast and mill products shipments for N.A. light vehicles expected to double by 2025



Source: Ducker August 2011, IHS

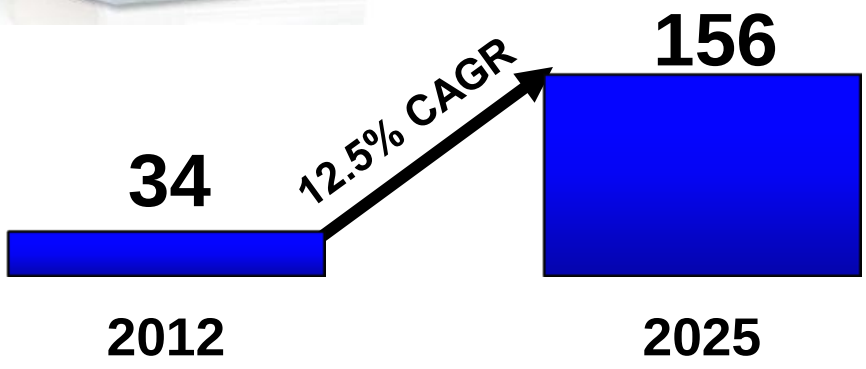
~5x aluminum flat rolled products content growth expected

Historic Applications

heat exchangers

closure panels

Aluminum pounds per U.S. light vehicle



Source: Ducker August 2011, Aluminum Association Transportation Group

Future Applications

closure panels

body in white

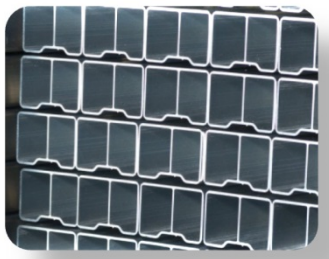
Aluminum extrusion content expected to maintain the historic 4% CAGR

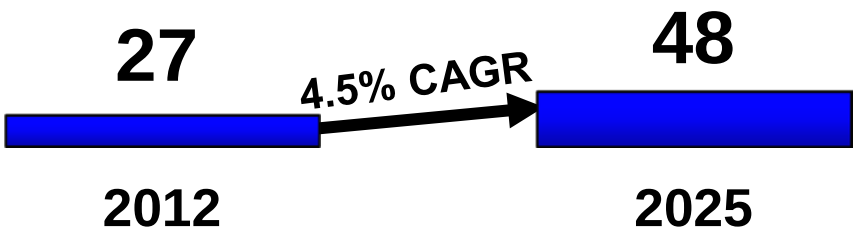
Historic Applications

brake systems

heat exchangers

Aluminum pounds per U.S. light vehicle





Source: Ducker August 2011, Aluminum Association Transportation Group

Future Applications

body in white

crash management

OSP - Automotive Aluminum Considerations

Aluminum Sheet/Extrusion

Material Management
- **lighter – easier to move**
- **water spotting - avoid moisture**
  - **transit, storage (precipitation, condensation)**
- **damageability - dent, scratch**
  - **“soft” tempers (T4 vs. T6)**

Slitting/Blanking
- **“Slivers” - tool design**

Inventory “SHRINKAGE”

Tailor welded blanks
- **Value proposition**

Extrusion: Precision cutting (0.2 mm), Miter cutting, Punching

Market Needs – OSP Opportunities

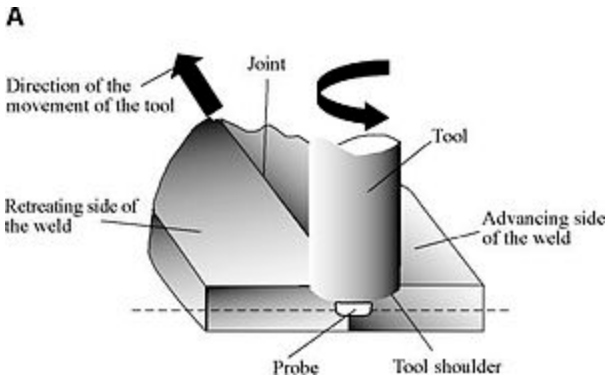
The Value Proposition: Cost Savings (Auto Body)

Material Utilization (blanking recovery)

Value: 3-4 X value of steel TWB

Greatest opportunity:

- **Tailor welded blanks**
  - **blank optimization**
  - **gauge optimization**
- **Laser welding**
- **Friction stir welding**
  - **avoid heat-affected-zone (HAZ)**

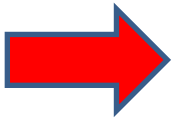


Aluminum Sheet & Extrusion Processing

OPC Industry Opportunity

- Significant Growth Potential
- Accommodate characteristics of aluminum

- Demand Driver: VALUE PROPOSITION (COST, COST, COST)
  (Must be technical success)



Material cost
Processing cost
System cost

Thank You!

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