



Steel vs. Aluminum Panel

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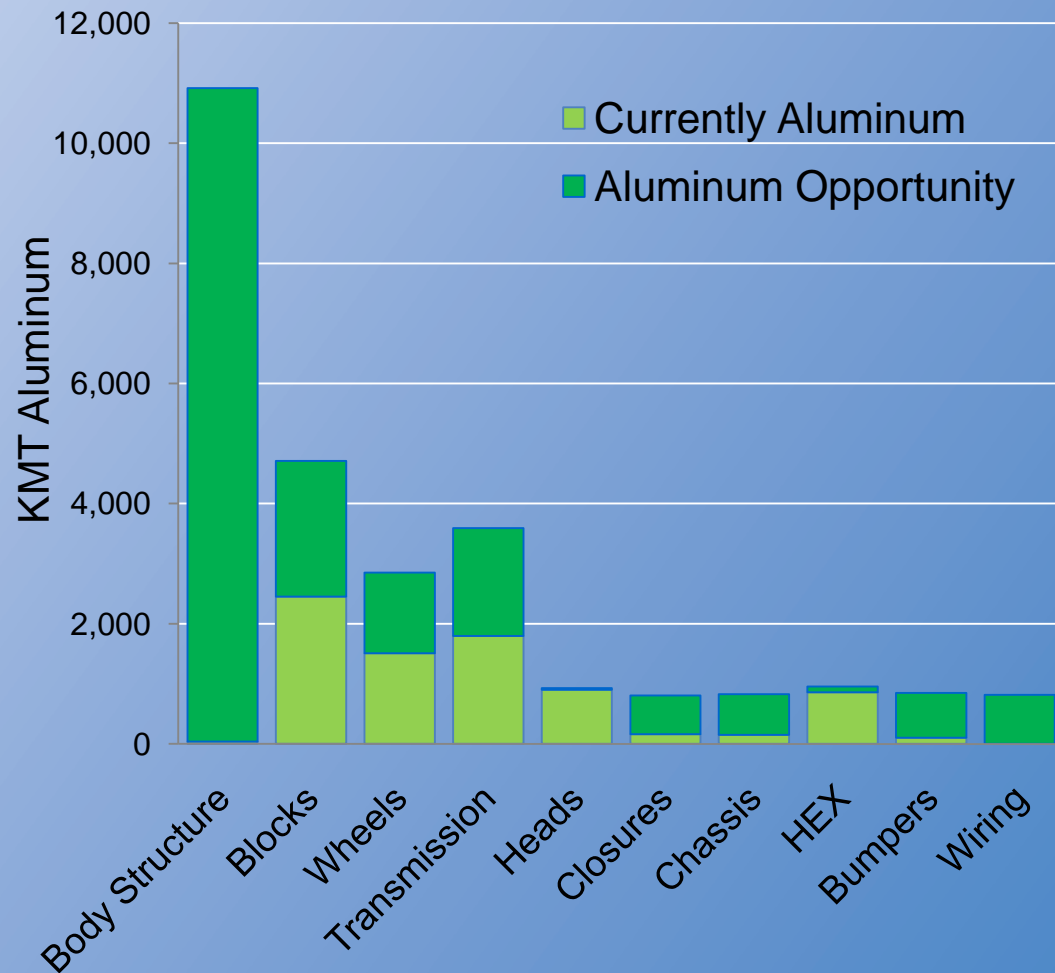


Down Weighting Cars is a Must

- Practical considerations:
 - How best to cut the weight?
 - Aluminum can safely take out more weight more than steel
 - No compromise to function – customers won't accept it
 - Lightweighting with aluminum is cost competitive
 - How much weight to cut?
 - As much as possible – half measures won't get the job done
 - 200 lbs saved = 1 MPG
 - How fast can we get there?
 - Aluminum uses many existing production processes

Body Holds the Largest Weight Reduction Opportunity

- Aluminum penetration continues to grow in many established areas
- Steel has historically dominated the auto body but...
- Potential future weight savings with steel are diminishing
- **Aluminum is the next logical step**



Aluminum Saves More Weight than High Strength Steel

- 3rd party research study completed at **University of Aachen** (2010)
- Car body analyzed in detail to select optimum material for each part
- Analysis of strength vs. stiffness requirements
- “Best” aluminum structure saved 40% body weight (525 lbs)
- “Best” steel structure could only save 11% - even with advanced steels



Steel alone is not the answer

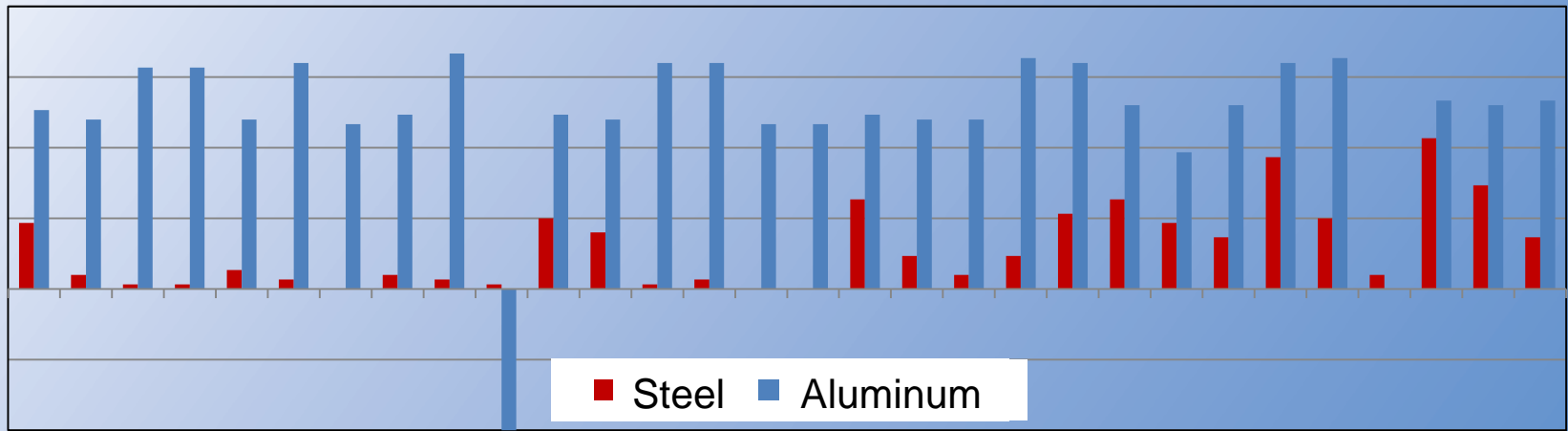
Aluminum's Lightweighting Advantages Are Clear

Total maximum weight reduction compared to reference car:

Steel (with YS up to 1,200 MPa): **11%**

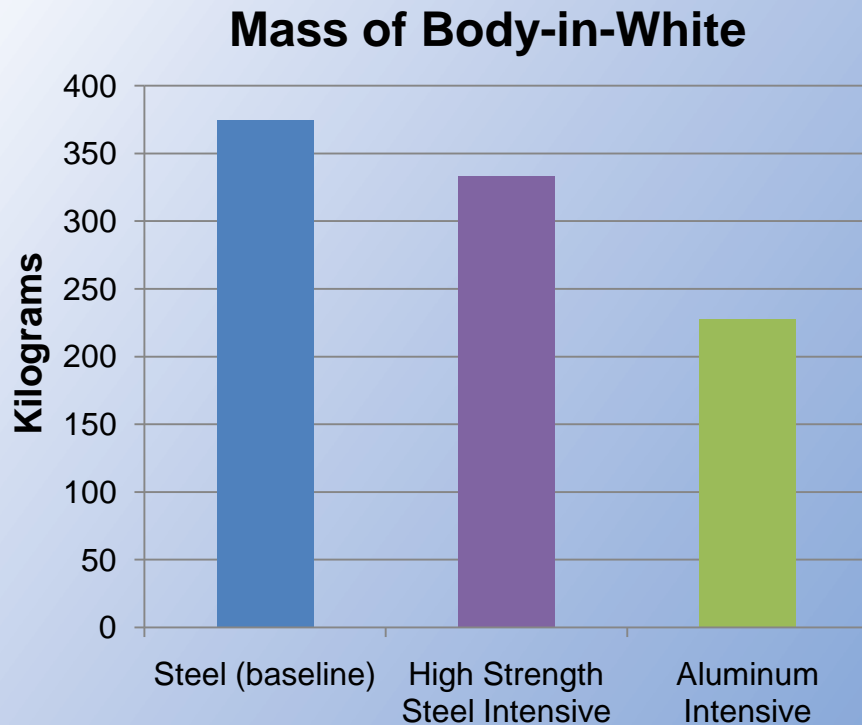
Aluminum (with YS up to 400 MPa): **40%**

Max. Lightweight Potential per Part

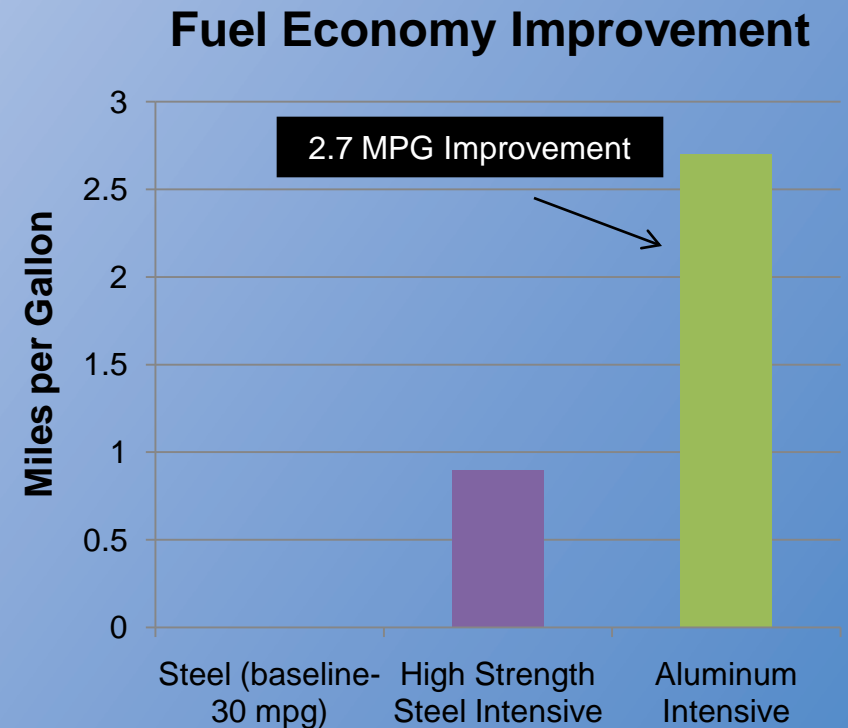


C-Pillar
 Door Frame
 Door Panels
 Door Rear Panels
 Door Rear Frame
 Hood
 Rear Crossmember
 Rearwall
 Roof
 Roofrail
 Sill
 Strut Tower Rear
 Fender
 Trunk Lid
 Door Hinge Reinforcement
 Door Rear Hinge Reinforcement
 Floor Crossmember
 Longitudinal Rear
 Strut Tower Front
 Sidewall
 Tunnel
 A-Pillar
 B-Pillar
 Cowl
 Firewall
 Floor
 IP Crossmember
 Longitudinal Front
 Longitudinal Upper
 Roof Crossmember

Aluminum's Weight Advantage Translates into Fuel Economy Advantage



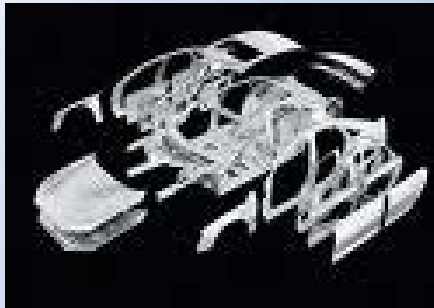
Source: ika - University of Aachen and the European Aluminium Association (EAA)



Source: Aluminum Association calculated based on ika mass reduction data; assumes 23% secondary weight savings

Cost-Effective Overall

MID-SIZE CAR EXAMPLE



	Al Weight	Wt. Reduction	Cost Impact
BIW	320 Lbs	280 Lbs	\$ 455
Closures	115 Lbs	70 Lbs	\$ 150
Structures	<u>45 Lbs</u>	<u>50 Lbs</u>	<u>\$ 160</u>
<u>Total (Direct)</u>	480 Lbs	380 Lbs	\$ 765
Optimization (In-direct)	<u>(50 Lbs)</u>	<u>170 Lbs</u>	<u>(\$ 665)</u>
<u>Net</u>	430 Lbs	550 Lbs	\$ 100

Multi material body:

AL Sheet 330 Lbs

Al Extrusion 60

Al Castings 30

Steel Sheet 50

HSLA Sheet 10

15% Weight Reduction

\$ 0.18 Per Lb Weight Reduction

A Real-World Example

Large Car with the Weight of a Mid-Size

- Roominess of a large car
- No compromise to safety
- Better mileage
- Same acceleration
- More agile handling & braking
- Existing stamping assets
- Lower powertrain cost

EPA Size Category	Large	Mid
Curb Weight Today	3199	2723
Weight Reduction with Aluminum body	(345)	
New Curb Weight	2698	

