MARKET RESEARCH
Ducker gathers unique market, customer and competitive insights when others cannot. Leveraging industry expertise and research capabilities, Ducker develops sound strategies to win in existing and new markets.

TRANSACTION ADVISORY
Ducker’s transaction advisors assist clients with searching and researching acquisition targets, and provide best-in-class diligence to de-risk M&A transactions. It’s a natural extension of our consulting and research services.

GROWTH CONSULTING
With a dynamic fact-based and advanced business analytics, Ducker works with management to develop actionable strategies and detailed go-to-market plans that represent best-fit solutions.
Americas
Troy, Michigan (Global Headquarters)

Europe
Paris, France
Berlin, Germany
London, United Kingdom

Asia-Pacific
Bangalore, India
Shanghai, China

Ducker Worldwide employs a seasoned team of 150 full-time consultants, located throughout North America, Europe, and Asia-Pacific.

Our team covers all major languages required to do business in Europe, Asia, India, Africa, and the Middle East. This ensures the best cultural fit and most accurate exchange of information needed to turn insights into effective decisions.

In addition to Ducker’s general markets served, Ducker Europe brings their considerable expertise to the emerging energy and environmental industries.

Ducker also offers operational consulting in India and critical data analytics for complex markets across the region.
SOLUTIONS FOR GROWTH IN COMPLEX MARKETS, IN TECHNICAL ENVIRONMENTS

AUTOMOTIVE & TRANSPORTATION
Manufacturers, tier suppliers and associations in the global transportation sector count on Ducker to deliver trusted insight.

BUILDING & CONSTRUCTION
From basic materials to advanced building performance systems, Ducker understands every aspect of the construction industry.

HEAVY EQUIPMENT
From mining, road construction and work at height applications, Ducker’s global access into the equipment industry provides seamless methods to identify and capture opportunity.

INDUSTRIAL
As reshoring of manufacturing continues and growth of automation reaches a new level, Ducker is there to help clients optimize their product/market strategies around the world.

MATERIALS & CHEMICALS
Ducker partners with clients in the materials and chemicals industry to build sustainable strategies and drive success, even as commodities and prices remain in constant motion.

HEALTHCARE
Our team helps companies navigate the changing face of healthcare, with solutions that support innovation and foster the growth of manufacturers and providers of medical equipment and provider business models.
LIGHT WEIGHTING MATERIALS
GLOBAL REGULATIONS DRIVE DEMAND FOR LIGHTWEIGHTING

EPA locks in 2025 fuel efficiency rules

David Shepardson

4 MIN READ

[1] China’s target reflects gasoline fleet scenario. If including other fuel types, the target will be lower.


REGULATORY BACKGROUND

Midterm Evaluation (MTE)
Three Step Process

On March 15, 2017, Administrator Scott Pruitt and Department of Transportation Secretary Elaine Chao announced that EPA intends to reconsider the final determination, issued on January 12, 2017.

On January 12, 2017, Administrator Gina McCarthy signed her determination to maintain the current GHG emissions standards for model year (MY) 2022-2025 vehicles.

Could be Revised!

September 6, 2017: Oral Arguments
October 5, 2017: Written Comments Due
April 1, 2018: FINAL DETERMINATION
THE ROAD TO COMPLIANCE IS A BALANCING ACT

7% Is Needed

Compliance - Gap
Cost Targets
Performance
Customer Needs
Global Goals
Plant Issues/Union

Powertrain
Materials (Body structures/chassis)
Design/Aerodynamic
REGULATORY WEIGHT SAVINGS GOALS: REDUCE 270 POUNDS!

Over 70% of the passenger cars will require mass reduction between 263 pounds per vehicle and 350 pounds per vehicle

Nearly 30% of the light trucks will require mass savings of approximately 840 pounds

Annual weight reduction targets goes from ~20 lb’s per year for 2015 to 2020 to ~34 lb’s per year for 2021 to 2025 or 7% reduction from 2015

Source: Ducker Analysis, Draft TAR Chapter 13

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CLOSING THE COMPLIANCE GAP IS A MULTISTEP PROCESS

**Where is the Weight: Light Vehicle Mass Distribution**

Body parts, closures, bumpers, chassis and suspension parts are the prime candidates for further weight reduction.

**Level 1 - Material Substitution**
One to One Part/Material Substitution: Closures, Bumpers, Knuckles, Control Arms etc.

**Level 2 - Holistic Weight Saving Designs**
Parts Consolidation, Multi-Form & Multi Material: sub-frames, front end modules, shock towers, door rings etc.

**Level 3 –**
Glazing/glass, coatings, interiors, etc.

Source: Ducker Analysis
It is unlikely there are breakthrough lightweight materials awaiting discovery – refinement of what is available today
COMPETING MATERIALS HAVE A PLACE IN THE MIXED MATERIAL FUTURE

The right material mix has to be evaluated for the right application and goals for the right budget!
MULTI-MATERIAL VEHICLES DEMONSTRATE THAT ONE SIZE DOES NOT FIT ALL

Multimaterial/Multiproduct body structures are the key to significant weight savings going forward.

**Cadillac CT6**
Aluminum VDC>170 lbs. in Color

**2018 A8 Body is 58% Aluminum**

**Materials: Mixed Metals**
*16 Cadillac CT6*
- High-strength steel/aluminum
- 64% of structure is aluminum, including body panels
- 198 lbs. lighter than steel body
- 21 patents pending

**BMW 7 Series**
High Strength Steels, Aluminum and CFRP

**Audi Q7 SUV**
Aluminum, Conventional Steels & High Strength Steels
The 2018 Audi A8 utilizes 13 joining methods
COMPLEXITIES IN THE MATERIAL MIX FOR THE FUTURE

To achieve a reduction of 270 PPV from 2015, significant content increases required in AHSS, Aluminum, Magnesium and CFRP

AUTOMOTIVE MATERIAL MIX PER VEHICLE

Source: 1Q2017Ducker Analysis
ALUMINUM MARCHES INTO THE NEXT DECADE WITH UNPRECEDENTED GROWTH

Aluminum penetration set to grow dramatically within closures, bumpers and structural castings: Aluminum remains the fastest growing automotive material...

North American Light Vehicle Aluminum Content
Net Pounds per Vehicle @ 7% MR Scenario by 2028

55 Years of Uninterrupted Growth

Sheet (Hood)
Extrusion (CMS)
Casting (Subframe)

Source: Ducker Analysis 1Q2017
MORE AHSS WILL BE NEEDED & GEN 3 STEELS ARE ON THE WAY

AHSS penetration surpassed Ducker’s prior estimates. Steel remains the single largest share of automotive materials.
SUPPLIER IMPACT CASE STUDY
SELECTING THE RIGHT MATERIALS TO FULFILL GROWTH MANDATE

Revenue Growth over 2020 levels for Premium Auto Materials

- Aluminum Sheet
- UHSS Sheet
- Material A
- Material B
- Material D
- Material E
- Material F
- Material G

Al Extruded Bumper Beams

- 2025 Scenario 2
- 2025 Scenario 1
- 2025 Base
- 2020

Millions Of Dollars
## CASE STUDY – CRASH MANAGEMENT SYSTEMS

<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Aluminum</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alloy/Grade</strong></td>
<td>HSS, AHSS, UHSS (PH)</td>
<td>6060, 6061, 6063, 6082, 7003</td>
<td>GMT, LFT-D, PC-PBT</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong></td>
<td>550MPa (up to 1700 MPa)</td>
<td>6xxx 300MPa</td>
<td>275MPa</td>
</tr>
<tr>
<td><strong>Energy Absorption</strong></td>
<td>Normal</td>
<td>Best</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1X (base)</td>
<td>0.5X to 0.7X</td>
<td>0.7X</td>
</tr>
<tr>
<td><strong>Cost (finished CMS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Adoption</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pros</strong></td>
<td>Lower cost</td>
<td>Lightweighting</td>
<td>Lightweighting</td>
</tr>
<tr>
<td></td>
<td>Repairable (non PH Steel)</td>
<td>Anti-corrosion</td>
<td>Anti-corrosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High energy absorption</td>
<td>High design flexibility (molding)</td>
</tr>
<tr>
<td><strong>Cons</strong></td>
<td>Corrosion</td>
<td>Higher cost</td>
<td>Not repairable</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>Not repairable</td>
<td>Low availability (Hanwha JV with AZDEL)</td>
</tr>
</tbody>
</table>
**Regulation/Test Standard**

**FMVSS Test Procedure for Regulation Part 581 Bumper Standard (NHTSA)**

- Prohibit damage to the vehicle surfaces and limit damage to passenger vehicle bumpers on vehicles under low speed (2.4 MPH)
  - Lamp and reflective device
  - Hood, trunk, doors
  - Fuel and cooling system
  - Exhaust system
  - Propulsion, suspension, steering, and braking system
- Limit the impact force levels for pendulum impacts to reduce the frequency of override and under ride

**Low-Speed Crash Test Protocol (IIHS)**

- Assess how well the bumper system can protect the vehicle from damage in an impact at 5 MPH speed
- Appraise bumper damage and estimate repair cost after impact
- Major components including reinforcement bars, energy absorbers for the front and rear bumper assemblies
- Minor cosmetic damages are permitted
MATERIAL STRATEGY EVOLUTION IS PART AND APPLICATION SPECIFIC

CMS Market Structure in NA

<table>
<thead>
<tr>
<th>Primary Process</th>
<th>Grade</th>
<th>LV Bumper Material</th>
<th>Grade</th>
<th>Primary Process</th>
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</thead>
<tbody>
<tr>
<td>Cold Stamped</td>
<td>AHSS</td>
<td>Mild/HSS</td>
<td>Steel, 66%</td>
<td>Extruded</td>
</tr>
<tr>
<td>Hot Stamped</td>
<td>UHSS</td>
<td>Aluminum, 34%</td>
<td>6xxx</td>
<td></td>
</tr>
<tr>
<td>Roll Formed</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Units in million</th>
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<tbody>
<tr>
<td>2016</td>
</tr>
<tr>
<td>23.8</td>
</tr>
<tr>
<td>23.8</td>
</tr>
<tr>
<td>35.8</td>
</tr>
<tr>
<td>12.0</td>
</tr>
<tr>
<td>12.0</td>
</tr>
</tbody>
</table>

CAGR (6.2%) (6.2%) 1.3% 12.6% 12.6%

<table>
<thead>
<tr>
<th>Units in million</th>
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</thead>
<tbody>
<tr>
<td>2020</td>
</tr>
<tr>
<td>23.8</td>
</tr>
<tr>
<td>37.7</td>
</tr>
<tr>
<td>Steel, 49%</td>
</tr>
<tr>
<td>Aluminum, 51%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units in million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll Formed</td>
</tr>
<tr>
<td>Hot Stamped</td>
</tr>
<tr>
<td>Cold Stamped</td>
</tr>
<tr>
<td>Mild/HSS</td>
</tr>
<tr>
<td>UHSS</td>
</tr>
<tr>
<td>AHSS</td>
</tr>
<tr>
<td>Steel</td>
</tr>
<tr>
<td>7xxx</td>
</tr>
<tr>
<td>6xxx</td>
</tr>
<tr>
<td>Extruded</td>
</tr>
</tbody>
</table>

Steel

Aluminum

23
VERTICAL INTEGRATION BRINGS OPPORTUNITIES

CMS Supplier Positioning

Example of supplier capability vertical integration (CMS)

<table>
<thead>
<tr>
<th>CMS</th>
<th>Cast Billet</th>
<th>Extrusion</th>
<th>Fabrication</th>
<th>Sub-Assembly</th>
<th>Tier I Integrator</th>
<th>Steel Stamping</th>
<th>Steel Roll Forming</th>
<th>Alloys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
<tr>
<td>Supplier B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx, 7xxx</td>
</tr>
<tr>
<td>Supplier C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx, 7xxx</td>
</tr>
<tr>
<td>Supplier D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
<tr>
<td>Supplier E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
<tr>
<td>Supplier F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
<tr>
<td>Supplier G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx, 7xxx</td>
</tr>
<tr>
<td>Supplier H</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx, 7xxx</td>
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<tr>
<td>Supplier I</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
<tr>
<td>Supplier J</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6xxx</td>
</tr>
</tbody>
</table>

Size: CMS Revenue

Tier 1&2: Tier 1 with extrusion capability
VALUE-ADD STEPS PROVIDE MARGINE EXPANSION AND CUSTOMER INTIMACY

Value Chain Positioning

Material: Xx%
Conversion Costs: Xx%
Value-Added Services: XX%
Total Price: 100%

Tier 2
Tier 1
THANK YOU.

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