Introduction

Alcoa Intro

Technologies
- Aluminum Frames/Crossmembers
- Casting alloy development
- Fasteners
- Wheels

Table of Contents

George Panourgias
Market Development Manager
Ground Transportation
Market Sector Team

Mario Greco
Director
Ground Transportation
Market Sector Team
Alcoa’s Corporate History

Our Company

The world has changed incredibly since we got our start in 1888. Over 12 decades, Alcoa has also grown and changed, thanks to our heritage of innovation and the commitment of our people. We invented the markets for our products and built the company to meet our customers’ needs.

From one committed scientist in a homemade lab in his family’s woodshed to thousands of dedicated employees at over 200 locations across 30 countries and six continents, our innovative solutions continue to revolutionize the world.

Alcoa. Advancing each generation.

Click on the images to learn more.

Alcoa Dates and milestones

1808
• Sir Humphry Davy, proved the existence of aluminium and gave it its name.

1884
• The total U.S. production was 56 kg of aluminium to a price about the same as silver.

1886
• The age of aluminium was born when Charles Martin Hall discovered the first process for smelting aluminium in large quantity.

1888
• The Pittsburgh Reduction Company was founded.

1904
Alcoa builds Aluminium Bodies in New Kensington for Ford Model T

1907
• Owners changed the company’s name to something more appropriate - Aluminium Company of America - later this changed to Alcoa Inc.

1908
Alcoa Dates and milestones

1907
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2008
• Alcoa celebrates 120th anniversary.

2011
• Aluminum celebrates its 125th anniversary

1923
Casted Aluminium-body of the Pierce Arrow
Worldwide Operations – Regional Strength
Upstream Co: Cost Competitive Industry Leader

Key Attributes and Global Business Unit 3Q15 Updates

- Robust projected aluminum demand growth of 6.5% in 2015 and double between 2010 and 2020
- Attractive Portfolio of five businesses:
  - World’s largest, low cost bauxite miner at the 19th percentile on cost curve (46M BDMT)
  - World’s largest, most attractive alumina business in the 1st quartile of the cost curve (17.3M MT)
  - Substantial energy assets with operational flexibility
  - Optimized smelting capacity (3.4M MT) continuing to improve its 2nd quartile cost curve position
  - 17 casthouses providing value-add products
- Diverse sites – close proximity to major markets
- Committed to disciplined capital allocation and prudent return of capital to shareholders

12-month Capacity Review
2.8 MMT Refining and 500 kmt Smelting

Key Attributes

ALUMINA

MINING

World’s largest bauxite miner

REFINING

1st quartile cost curve refiner

ENERGY

Flexibility to profit from market cycles

ALUMINUM

SMELTING

Strategic global footprint

CASTING

Value-add products in key markets

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1) CRU analysis. 2) Mined in 2014, including equity interests. 3) CRU and Alcoa analysis. 4) Announced March 6, 2015

BDMT = Bone Dry Metric Ton
**Value-Add Co: Premier Provider of Innovative Solutions to Growing Markets**

**Value-Add Co. Business Operations and Key Attributes**

- **Key Attributes**
  - Premier provider of high-performance advanced multi-material products and solutions
  - Positioned to grow in growth markets with significant customer synergies e.g., aerospace, automotive, commercial transportation, building and construction
  - Expanded multi-material technology and process expertise
  - Innovation leader with full pipeline of products and solutions
  - Successfully shifting product mix to higher value-add
  - Robust margins and investment opportunities above cost of capital

<table>
<thead>
<tr>
<th>GRP</th>
<th>EPS</th>
<th>TCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerospace and Automotive Products</strong></td>
<td><strong>Power and Propulsion</strong></td>
<td><strong>Building and Construction Systems</strong></td>
</tr>
<tr>
<td>Global Leader in the automotive &amp; aerospace markets</td>
<td>Global Leader in jet engine and industrial gas turbine airfoils</td>
<td>N.A. Market Leader in commercial architectural systems</td>
</tr>
<tr>
<td>Brazing, Commercial Transportation and Industrial Products</td>
<td>Fastening Systems and Rings</td>
<td>Wheels and Transportation Products</td>
</tr>
<tr>
<td>Global Leader for heat exchanger, commercial transportation and industrial products</td>
<td>Global Leader in aerospace fasteners and jet engine rings</td>
<td>Global Leader in forged aluminum commercial vehicle wheels</td>
</tr>
<tr>
<td>Micromill Products and Services</td>
<td>Forgings and Extrusions</td>
<td></td>
</tr>
<tr>
<td>Bringing breakthrough products and technology to customers around the world</td>
<td>Global Leader in aero, defense structures &amp; jet engine disks</td>
<td></td>
</tr>
<tr>
<td>Global Packaging</td>
<td>Vertically integrated player in the Ti value chain</td>
<td></td>
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</table>

**GRP = Global Rolled Products, EPS = Engineered Products and Solutions, TCS = Transportation and Construction Solutions, MENA = Middle East and North Africa**
Alcoa products and solutions service many different markets

<table>
<thead>
<tr>
<th>Primary Aluminum</th>
<th>Transportation</th>
<th>Packaging</th>
<th>Building/Construction</th>
<th>Aerospace</th>
<th>Industrial</th>
<th>Oil &amp; Gas</th>
<th>Consumer Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingot</td>
<td>Sheet, castings, extrusions</td>
<td>Sheet for aluminum beverage cans and bottles</td>
<td>Reynobond /Reynolux Aluminum Composite Material</td>
<td>Sheet/Plate for fuselage skins</td>
<td>Sheet</td>
<td>Aluminum drill pipe</td>
<td></td>
</tr>
<tr>
<td>Rolling slab</td>
<td>Forged wheels</td>
<td>Kawneer windows, curtain wall systems, entrances, framing</td>
<td>Structural forgings</td>
<td>Plate</td>
<td>Plate</td>
<td>Riser systems</td>
<td></td>
</tr>
<tr>
<td>Extrusion billet</td>
<td>Recycling</td>
<td>Fastening Systems</td>
<td>Cast turbine blades</td>
<td>Forgings</td>
<td>Forgings</td>
<td>Thermal management for displays</td>
<td></td>
</tr>
<tr>
<td>Cast Rod</td>
<td></td>
<td>Enclosure design and surface treatments</td>
<td></td>
<td>Hard-alloy extrusion</td>
<td></td>
<td>Forgings for display manufacturing</td>
<td></td>
</tr>
</tbody>
</table>

- Ingot
- Rolling slab
- Extrusion billet
- Cast Rod
- Sheet, castings, extrusions
- Forged wheels
- Sheet for aluminum beverage cans and bottles
- Kawneer windows, curtain wall systems, entrances, framing
- Reynobond/Reynolux Aluminum Composite Material
- Structural forgings
- Fastening Systems
- Cast turbine blades
- Sheet/Plate for fuselage skins
- Sheet
- Plate
- Forgings
- Hard-alloy extrusion
- Sheet
- Plate
- Forgings
- Enclosure design and surface treatments
- Thermal management for displays
- Forgings for display manufacturing
Alcoa is pursuing a global strategy in Commercial Transportation where freight efficiency and aesthetics play a role in specifications process.

**Commercial Transportation Market at a Glance**

### Global Drivers
- Increase Payload
- CO₂ Targets
- Fuel Prices
- Lifecycle Benefit

### Levers
- Aerodynamics
- Combustion
- Mass Savings
- Transmission
- Lubrication
- Electrification

Source: Alcoa
The importance of lightweighting is becoming increasingly more significant and Alcoa offers solutions saving over 2,500 pounds.

Shedding weight can save fuel costs, reduce emissions or generate revenue through greater payloads.

Over 2500 lbs of weight savings.

Source: Alcoa
Trucking Efficiency report finds lightweighting technology could save $1 million over five years

**Benefits**

- **Increase fuel efficiency**
  - 0.5%–0.6% of fuel is saved per 1,000 pounds of weight reduction.

- **Increase freight efficiency**
  - Every pound shaved off the vehicle’s weight could be recouped as freight.

- **Driver retention**
  - Amenities add weight to a truck, making lightweighting important if fleets hope to continue shipping even their current quantities of freight.

- **Allow the adoption of fuel efficiency technologies**
  - Fuel efficiency technologies add weight to the truck.

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**THE ART OF EFFICIENCY THROUGH LIGHTWEIGHTING**

**4 REASONS LIGHTWEIGHTING HEAVY-DUTY TRUCKS PAYS OFF**

- **More weight.** 1,000 lbs. added per tractor in the past 10 years.
- **Higher fuel costs.** Fuel costs double every 10 years.
- **Heavy freight.** Shippers losing more freight per truck.
- **Government regulations targeting vehicle weight.**

**THE BOTTOM LINE:** Lightweighting is the economical solution.

Investing in lightweighting could save a fleet nearly $1 million over 5 years.

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Source: North American Council for Freight Efficiency
Alcoa has been involved in lightweight Bus solutions in China for over a decade.

Bus development projects

- **2006**: 1st Gen City Bus
  - Yutong

- **2010**: 2nd Gen Electric City Bus
  - BYD

- **2013**: 1st Gen Coach Bus
  - Marcopolo

- **2015**: 3rd Gen City Bus
  - Higer, Ankai, BCI
Alcoa can provide comprehensive technical capabilities and a turn key service

**Technical Capabilities**
- CAD Design
- Finite Element Analysis (Static and Dynamic)
- Crash
- Manufacturing Expertise with Aluminum Structures
  - Assembly / Joining / Training / etc
- Prototyping Support

**Recommended Approach**
- Industrial Design
- Section changes
- Huck fastening final assembly / Welded sub-assembly
- Extruded, with skins
- Optional Chassis design
- Modularity
Alcoa Technical Center (ATC)

Over 500 employees innovating new Alcoa products and processes at the world’s largest light metals research facility (aluminum, nickel, titanium, and ceramics)

Full Range of Lab Capabilities

• Bench-scale to full production-scale
• Production Casting (Al-Li)
• Research, Development and Applied Engineering
• Multi-Materials Manufacturing Capabilities

• Global connections to satellite R&D operations
• Pilot plant facilities (Smelting, Rolling, Casting, Wheels, Shaping, etc.)

Research & Development Locations:

- Alcoa Technical Center, PA, USA
- Carson, CA, USA (fastening systems)
- Kwinana, Australia (refining)
- Whitehall, MI, USA (investment castings)

$270M Global R&D for 2015

$160M ATC
$110M BU

$150M

Advancing each generation.

ALCOA
Innovation transforms our business; high growth, differentiated products

Providing innovation expertise
- Coatings
- Basic Science
- Alloy Development
- Casting
- Process Control
- Modeling
- Pilot Production
- Forming
- Joining

Across businesses and markets
- GPP
- Energy
- Industrial Metals
- Aerospace
- B&C
- Defense
- Auto
- Commercial transport
- Industrial Packaging
- GRP

To deliver customer solutions
- Hybrid metallic fan blade
- Aluminum lithium casting
- Next-gen foundry alloys
- Additive Manufacturing
- Aluminum air battery

Alcoa: Founded on Innovation
ALUMINUM FRAME & CROSSTREETMEMBERS
Volvo DOE Supertruck Program – Chassis

Supertruck Technology Approach

**Approach: Technology Content**

**Fuel Savings**
- 40% aerodynamic drag reduction
- 20% lower rolling resistance
- 50% BTE powertrain
- 'look-ahead' energy management
- intelligent auxiliary control
- kinetic energy recovery
- driver coaching

**Weight Savings**
- 40% lighter chassis
- engine downsizing
- composite aero fairings
- 6x2 axle & wide base tires
- Light trailer suspension & slider box
- light gauge wire harness

**Freight Efficiency Target**
- electric HVAC system
- improved cab insulation
- LED lighting in & out
- integrated solar power
- Hotel Loads

Measured on 24-hr duty cycle

Source: Amur, Pascal, "Volvo Super Truck", 2015 DOE Annual Merit Review Presentation
As a result of designing frame rails with high strength, roll formed aluminum sheet, over 850 lbs are saved over the conventional system.

Frame Design uses variable height rails
- Top and bottom rail components were 6.3 mm (0.25 in) thick
- Roll formed on Metalsa’s existing frame rail line and offset on existing equipment
- New Versacast permanent mold casting alloy used for cast aluminum spring hangers saves 8 lb per casting

Savings of 850 lb over baseline steel frame
- Increased the torsional frame stiffness by a factor of 4
- Equivalent strength
- Durability testing ongoing

Source: Metalsa
Cyclic Corrosion test for underbody components (most severe 93 cycle requirement)

- Ambient stage – 25 deg C with 45% humidity for 8 hours with dip in 1% complex salt solution every 2 hours.
- Humid stage – 49 deg C with 100% relative humidity for 8 hours
- Dry stage – 60 deg C with < 30% humidity for 8 hours

Source: Alcoa
Through CAE methods, we can convert and optimize existing cross members into lighter, aluminum versions.

Proposed design in aluminum:

Total Weight: 19.1 kg

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Weight Savings</th>
</tr>
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<tbody>
<tr>
<td>Existing Steel Cross Member</td>
<td>34</td>
</tr>
<tr>
<td>Proposed Aluminum Cross member</td>
<td>19.1</td>
</tr>
</tbody>
</table>
Nearly 50 percent weight saving can be achieved by converting to equivalent aluminum designs.

### Steel Design
- Steel Thickness = 4.8 mm (0.187”) each
- Weight (total) = 15.44 kg (33.97 lb)

### Aluminum Design
- Aluminum thickness = 7.8 mm (0.31”)
- Weight (total) = 8.3 kg (18.26 lb)
- Savings = 46%

Initial trial and analysis – 6013-T4
\[ t= 0.31 \text{ inches} \]
As much as 45 kgs of weight savings per vehicle can be realized by converting the cross members to aluminum.

<table>
<thead>
<tr>
<th>Cross member Application</th>
<th>Wgt Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear Cross member</td>
<td>2 kg</td>
</tr>
<tr>
<td>Bogie</td>
<td>15 kg</td>
</tr>
<tr>
<td>Front of bogie</td>
<td>7 kg</td>
</tr>
<tr>
<td>Intermediate</td>
<td>7 kg</td>
</tr>
<tr>
<td>After transmission</td>
<td>6 kg</td>
</tr>
<tr>
<td>Over transmission</td>
<td>3 kg</td>
</tr>
<tr>
<td>Front Closing</td>
<td>5 kg</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>45 kg</strong></td>
</tr>
</tbody>
</table>
CASTING MATERIALS
New proprietary casting alloys enable lighter chassis and suspensions, and more efficient advanced engines

Alcoa casting alloys for next generation vehicles

Alloy development + casting technology

New foundry alloys with enhanced properties:

- ~2X strength at 300°C
- ~50% better fatigue resistance
- Excellent corrosion resistance and conductivity
- Better fluidity and castability for complex, thin walled shapes; enables novel casting processes

40 - 50% weight of cast iron

EZCAST™ & VERSACAST™

- Cross members
- Spring hanger bracket

EVERCAST™

- Steering knuckles
- Hollow control arms
- Suspension arms

SUPRACAST™

~2X strength at 300°C
50% better fatigue resistance
Excellent corrosion resistance and conductivity
Better fluidity and castability for complex, thin walled shapes; enables novel casting processes
40 - 50% weight of cast iron
Boost Payload with VersaCast™

- A versatile, high strength alloy with excellent castability characteristics
- A cost effective, light-weight alternative to iron and steel structural castings
- Enhanced mechanical properties vs. standard aluminum alloys with increased flexibility to realize complex designs
- Excellent fatigue resistance resulting in maximum reliability and performance over the life of the vehicle
- Ideal for structural applications such as control arms, brackets, knuckles and calipers
Alcoa Fasteners Value Proposition

- Direct tension installation
- Tight clamp control
- Visual inspection
- Vibration
- Lower installed cost
- Less operator fatigue
- Fast installation

Standard chassis fasteners for Peterbilt since 2008, as well as Volvo and Daimler.

Huck Fastener product used for over 20+ years.
Trimmed Flange Collar with Swage Indicator

- 20% weight reduction per collar, cuts 5 pounds per truck
- Collar height shortened by 2 mm allowing shorter pin to be used
- 55 KSI (380 MPa) or higher bearing yield material will support flange
- Knurled band feature provides visual verification of full swage
AFSR pursuing a concept 16mm Huck Bolt with a higher clamp load of 130 kN.

- Higher clamp equals less fasteners, less weight and reduced assembly time.

- Clamp load per dollar increases by 15%.

- The “Big Deal” - Near 12.9 tensile and clamp at 10.9 Bolt hardness.
New HuckGuard® Coating

What is HuckGuard?

A dry film lubricant applied over Geomet or electroplate zinc to balance corrosion resistance of the swaged collar to the pin

- Withstands high contact pressure applied to swaged collar
- Extends hours to red rust on SWAGED collars from 50 hours to over 500 hours!
- Equivalent to Geomet coated Huck Bolt pin
- Paint adheres to Huck Guard, simplifying paint prep
Axle Connections

- Traditional U-bolts must be maintained at 10,000 and 50,000 miles
- Consistent, even clamp applied to each bolt leg during installation
- Huck U-Spin® provides a permanent joint and removes any risk of voiding the warranty
- Fast easy installation ~1 minute per axle
Huck 360 Only True Locking Bolt & Nut

The World’s Best Lock Nut Technology Combined With One Tough Bolt.

This innovative design features:
- A low stress concentration thread form resulting in 7X fatigue life
- A free running thread for fast fit up with less operator fatigue.
- The highest resistance to vibration loosening for safe reliable connections.

“The Inside Story”
- Standard Nut & Bolt: Thread clearance can’t stop vibration induced slippage and loosens
- Huck 360™: Nut wraps around bolt thread to eliminate vibration induced slippage

“The Results”
- A fastener that vastly outperforms the competition in transverse vibration testing

At last, a fastening system that provides lock bolt performance while being fully field serviceable with standard tooling.
Potential Huck 360 Applications

Brake Spider
- Front and Rear Axles

Suspension Pivot Bolts

Production Savings
Fast assembly
- Free running nut installs twice as fast.
- Eliminates costly Nylock & Loctite

Labor Reduction

Improved Safety
Eliminates torque reaction
Reduced noise level

Efficiency Improvement
Reduced Clamp Scatter ± 40% to ± 20%

Product Improvements
Maintenance Free
Serviceable Connections
High vibration and fatigue strength
ALUMINUM FORGED WHEELS

Advancing each generation.
3rd Generation

10x more resistant to corrosion

3x more resistant to harsh chemicals

Cleans easier ... and stays cleaner longer

Mild Soap & Water wash for a Long Lasting Shine

Launch and conversion timeline

Launch at MATS 2015

Late July 2015 convert high volume wheels: 88367 and 98367. Monterrey production

Jan 2016 convert balance of portfolio. Cleveland production
Alcoa developed the world’s lightest commercial truck wheel in its class!

- **Lightest in Industry** at just 45 lbs
- **6x brighter** than competition
- **Two sided** polished finish

LvL ONE® - Introduced in 2009

- **Proprietary** alloy
- **17% stronger**
- Compatible with **all finishes**

MagnaForce™ - Launched Q4 2013

- **22.5 x 8.25 wheel** at **Just 40 lbs**
- **5 lbs lighter**
- **~100 lbs savings** per 18 wheeler

Light Weighting Wheels is in our DNA
Leveraging MagnaForce™ alloy to lightweight 3 more product families

- Our next Ultra ONE™ wheels with MagnaForce™ alloy ...

### 22.5 x 14 wide-base
- Just **52 lbs** (0,2,1 off-set)
- 2 lbs lighter
- Launch at MATS 2016

### 24.5 x 8.25 standard
- Just **52 lbs**
- 2 lbs lighter
- Launch at MATS 2016

### 22.5 x 9 standard
- Just **49 lbs or 57 lbs**
- 2 lbs lighter
- Launch at MATS 2016