Outlook for Aluminum in the Commercial Airplane Market

John Byrne
Vice President- Supplier Management
Aircraft Materials and Structures
Boeing Commercial Airplanes

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Airlines will need 38,000 new airplanes valued at $5.6 trillion

### Airplane deliveries: 38,050

<table>
<thead>
<tr>
<th>Type</th>
<th>Airplanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional jets</td>
<td>2,490</td>
</tr>
<tr>
<td>Single-aisle</td>
<td>26,730</td>
</tr>
<tr>
<td>Small wide-body</td>
<td>4,770</td>
</tr>
<tr>
<td>Medium wide-body</td>
<td>3,520</td>
</tr>
<tr>
<td>Large wide-body</td>
<td>540</td>
</tr>
</tbody>
</table>

### New airplane deliveries by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Airplanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>14,330</td>
</tr>
<tr>
<td>North America</td>
<td>7,890</td>
</tr>
<tr>
<td>Europe</td>
<td>7,310</td>
</tr>
<tr>
<td>Middle East</td>
<td>3,180</td>
</tr>
<tr>
<td>Latin America</td>
<td>3,020</td>
</tr>
<tr>
<td>Africa</td>
<td>1,170</td>
</tr>
<tr>
<td>C.I.S.</td>
<td>1,150</td>
</tr>
<tr>
<td>World Total</td>
<td>38,050</td>
</tr>
</tbody>
</table>
Global fleet will double

Units

2014

2034

Global fleet will double

21,960

Growth
58%

16,090
Replacement
42%

5,510
Retained fleet

21,600

20,000

38,050

43,560

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2014 highlights

Sold 1,432 and delivered 723 airplanes – both Boeing records!
Launched 737 MAX 200
Achieved firm configuration on 787-10
Delivered 787-9 into passenger service
Celebrated KC-46A tanker first test flight
Began construction on new 777X Composite Wing Center
787 Dreamliner opening new markets
More than 42 new nonstop markets now connected with the 787

Announced routes in-service, pending commencement, or approval
As of January 2015
Boeing product line-up
Superior value, efficient market coverage

Current Boeing

747-8
777-300ER
777-200ER
787-9
787-8
767-300ER
737-900ER
737-800
737-700

Future Boeing

747-8
777-9X
777-8X
787-10
787-9
787-8
737 MAX 9
737 MAX 8
737 MAX 7
BCA production rates outlook

Anticipate ~60% rate increase from 2011 through 2017

Aggregate of all airplane programs

<table>
<thead>
<tr>
<th>Year</th>
<th>737</th>
<th>747</th>
<th>757</th>
<th>767</th>
<th>777</th>
<th>787</th>
<th>797</th>
<th>End of Decade</th>
</tr>
</thead>
</table>

Updated As of: 2/10/15
Boeing Commercial Airplanes supply chain

1 billion parts procured per year

- 737: 400 thousand parts
- 767: 3.1 million parts
- 787: 2.3 million parts
- 777: 3 million parts
- 747-8: 6 million parts

$43 billion spend • 5,400 factories • 500,000 people

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Competition and customer expectations

Aggressive competition

- Traditional
- Emerging

Customers’ “more-for-less” expectations

- Affordable and mission-capable
- Low operating cost
- Environmentally progressive
- In-service reliability
- Standardization, first-time quality
Partnering for Success

1st Time Quality
- Quality parts
- Production readiness

Design Cost Out / Lean+
- Design changes
- Productivity improvements

Supply Chain Architecture
- Strategic sourcing
- Value creation / innovation

Competition / Commercial Rebalancing / Volume
- Balance risk & reward
- Statement of work adjustment

Affordability focus areas
Raw material strategy

- Boeing designs what is needed for airplane performance
  - Materials are then tailored to fit that need
- Aluminum, in particular, has had an important role in aircraft production with the onset of many specific alloys used for various areas on the aircraft
  - High strength sheets/slabs for coverings
  - Complex blocks for components for engines, propellers, chassis, and frames
  - Soft low-alloy aluminum-magnesium variants were used for rolling wire; rivets, welding

Today major producers of aluminum alloys are spread across the globe

Boeing Aluminum Supply Base (Current)

- Alcoa – Hard Alloy Extrusions (HAE), Flat Rolled Products (FRP), Forgings
- Aleris – FRP
- AMAG – FRP
- Constellium – FRP
- Kaiser – FRP & HAE
- Minalex – Soft Alloy Extrusions
- Taber – HAE
- UAC – HAE
Some of the most common aerospace uses for aluminum materials

- **7055** – Wing plate for higher strength
- **7075** – Thin, sheet type applications
- **6061/6013** – Tubing, brackets for high forming ability with low cost
- **2024/2524** – High damage resistance, fuselage skins
- **2324** – Lower wing skins for added strength
- **2219** – Heat resistance for semi-hot areas (struts)
- **7050** – Heavy, thick applications (forgings)
- **7075** – Thin, sheet type applications
- **A356/A357** – Castings
- **6061/6013** – Tubing, brackets for high forming ability with low cost

Aluminum mills must continue to innovate to remain competitive with composites and titanium (cost, weight, strength, etc.)
Trends in aluminum

Near term focus
- Inventory optimization
- Volumes increasing with production rates (capacity is a concern)
- More monolithic structures (less sub-assembly buildup)
- Implementing scrap revert collection
- Risk mitigation strategies to remove price variability
- New Alloys need to buy their way onto the airplane

Long range needs
- Aluminum will continue to be largest content in commercial airplane manufacturing
- Continue to innovate as competing technologies (e.g. composites) come down cost curve
- Integration of composites and aluminum in aerospace applications
Supply chain challenges

- Supporting peak build rates
- Demand management
- Vertical Integration
- Consolidation
- Capitalization
- Affordability

Affordability is the new market differentiator