World Titanium Demand Trends in Structures

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The large commercial aircraft market has never been this good

**Record Everything**

- **Deliveries**: >1,600 aircraft in 2018*
- **Backlog**: ~13,000 units*
- **Relative Backlog**: Over eight years of production at 2018 delivery rate

*Boeing and Airbus
Source: The Airline Monitor, February 2019 (includes Large Commercial Aircraft + Regional Jets)
Near-term outlook is supported by years of strong orders

The enormous wave of net orders post financial crisis were the product of three drivers:

- High jet fuel prices
- Low interest rates
- New, more fuel-efficient aircraft designs

Large Commercial Aircraft orders show continued strength with 2018 recording a year-end book to bill >1

Source: Airline Monitor, June 2017; Airbus and Boeing websites; excludes A220/CSeries
Long-term outlook projects 42K+ new aircraft over next 20 years

- Results in a 2037 fleet of 48,540 aircraft – approximately 2X what it is today
- Dollar value pegged at $6.3 trillion

Regional Jets: 6% of deliveries | 2% of market value
**Single Aisle:** 73% of deliveries | 55% of market value
Widebody: 19% of deliveries | 39% of market value
Freighters: 2% of deliveries | 4% of market value

Source: Boeing 2018 Commercial Market Outlook
Airline forecasts are reinforced by strong air traffic demand growth

2018 Industry Growth Drivers

- Industry growth drivers show **continued strength**
- By 2037, an estimated 85% of emerging country populations will fly, up from 30% in 2017

World Annual Airline Traffic and RPKs

- Travel demand projected to far outpace GDP growth
- Traffic has proved to be resilient to external shocks; doubles every 15 years

1) In trillions of Revenue Passenger Kilometers; Source: Airbus March 2019
Fuel prices have been increasing, but they are within a “sweet spot”

- High enough to encourage airlines to continue to purchase more fuel-efficient models
- But not so high as to raise ticket prices that would discourage air travel demand
Positive outlook is bolstered by the airlines’ ability to pay for aircraft

- **Profitability of nearly $32B** in 2018 followed by a projected **$34B** in 2019; airlines maintaining focus on generating increased ROIC

- Strong drivers of solid **passenger growth (+6.5% in 2018)** and rising passenger **load factors (>80%)**

- Higher fuel prices take a toll on airline profitability, but upward trend continues to support investment in newer, more fuel-efficient models

Source: IATA, December 2019
Fighter/Attack aircraft budgets are rising, dominated by the JSF

- Lockheed delivered 91 F-35’s in 2018 - by 2023, production is slated to rise to 160 units per year
- USAF budget request included eight F-15s next year and 72 in the following four years – this, for a platform the USAF hasn’t purchased for over a decade

Source: The Teal Group, April 2019
Titanium growing at CAGR of 1.4% through 2023

- **Next-gen** aircraft shifting to greater use of composites in wing and engine structures

- **Titanium growing** in conjunction with composites due to the materials’ **compatible properties**

- **Raw material demand** growth measured in volume (lbs) will be **lower than aircraft** unit growth due to:
  - Lower **buy-to-fly** ratios
  - Greater use of composites

- **Titanium** will grow the **fastest** among metals with CAGR of 1.4%

Source: Charles Edwards, March 2019
The supply side challenge is how to profitably deliver the backlog

- **Industry shift**: Era of Design to Era of Delivery
- **Supply Chain / “Teething” Issues**: How to keep pace with the ramp
- **The Supplier Squeeze**: Pressure to reduce costs and improve efficiency
- **Industry Restructuring**: M&A activity across the sector is picking up speed and insourcing decisions are becoming the norm
Multi-step value streams support product and process innovation

Arconic Engineered Structures

Delivering complete, lightweight, multi-material solutions from raw material to finished part
Product and process innovation will help drive titanium growth

**Challenge:** Next-gen engines running hotter; challenge for adjacent structures

**Opportunity:** Higher-temp Ti solution

**Innovation:** ARCONIC-THOR™ 50% lighter than incumbent Ni superalloys

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**Challenge:** Pressure to ↓ costs, ↑ efficiency

**Opportunity:** Hybrid advanced manufacturing

**Innovation:** Arconic Ampliforge™ Faster, lower cost Ti forging option