AEROSPACE INDUSTRY DYNAMICS

Implications for the Titanium Market

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Agenda

- Aerospace Production Outlook
  - Titanium Demand Outlook
  - Key Trends
Oil Prices Are Approaching the High Levels of the 2008 Price Spike

Annual Average Fuel Costs
1978 to present (cents per gallon)

2002: 11% of airline expenses
Current: 30+% of airline expenses

Source: Air Transport Association, IATA
Annual Aircraft Production Climbs from 4,200 to Over 5,000 Units By 2017

Aggregate Production Market
2011-2021, By Market Segment

- Military Fixed Wing, -4.5%
- Business & Gen Aviation; 5.2%
- Rotary Wing; 0%
- Air Transport; 3.4%

Total CAGR = 2.1%

Source: ICF SH&E
Air Transport Production Will Increase from 1,200 to Over 1,800 By 2021, Led By Boeing and Airbus

* Drop in production rates from 2014 to 2016 is due to a change in orders, shifting from legacy aircraft to next generation—see following page

Total CAGR = 3.4%
There Will Be a Fundamental Shift from Legacy Aircraft to Next Generation Aircraft, Occurring Mid-Decade

Air Transport Production Market
2011-2021, Narrowbody Vs. Widebody

Why the fall in production rates?

• High fuel prices (30%) mean that airlines will defer orders for legacy aircraft
• Aggregate production rates will fall in the transition – this is also the experience of past re-enginings of the B737 in the mid-1980s and late 1990s

Source: ICF SH&E
Business Aviation Production Will Recover and Reach 1,600 Units in the Latter Part of the Decade

Business & General Aviation Production Market
2011-2021, (Turbine-Powered Only)

Source: ICF SH&E
Rotary Wing Production Should Remain Relatively Flat Over the Decade, With Initial Growth Spurred By the Military

Rotary Wing Production Market
2011-2021, By OEM

Source: ICF SH&E
Military Fixed-Wing Production Will Decrease Readily, Yet Strong JSF Production (Lockheed) Will Help to Mitigate the Decline

Military Fixed Wing Production Market
2011-2021, By OEM

Source: ICF SH&E
Annual Aero-Engine Production Should Exceed 10,000 Units By 2021, Including Production Units and Spares

Aero-Engine Production Market
2011-2021*, By OEM

* Includes Spares
Source: ICF SH&E
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Total Aerospace Material Demand in Buy Weight is 1.14B Pounds, Led By the Air Transport Sector

2010 Aerospace Raw Material Buy Weight*
(Fundamental Mill Demand)

- Air transport is nearly three-quarters of the total demand
- Military fixed wing is the second largest category, which includes platforms such as the Boeing tanker program (KC-46A) and the Joint Strike Fighter

* Maintenance, repair and overhaul (MRO) included in total
** Includes air transport aircraft used as VIP transport, contributing roughly 12% to the total

Source: ICF SH&E
The systems with the highest titanium content are engines, nacelles, and hardware (i.e., fasteners).

Titanium is also used in some aircraft components – primarily for landing systems.

Maintenance, repair and overhaul (MRO) consumes titanium for certain engine parts (disks, blades, vanes, stators, seals).
Titanium Constitutes Nearly 10% of Total Aerospace Raw Material Demand

2010 Aerospace Raw Material Buy Weight* (Fundamental Mill Demand)

- Aluminum alloys are half of the total demand
- Steel alloy and titanium increases in importance (relative to the percentage of fly weight, 17% and 8% respectively) due to relatively high buy to fly weights for the materials
- Composites is just 3% of total demand due to its low buy-to-fly ratio

* Maintenance (MRO) included in total
Source: ICF SH&E
The Total Aerospace Raw Material Market is Nearly $9 Billion; Titanium’s Value Comprises 26%, or $2.2B

- Aluminum and titanium are the largest material markets by value – both are worth ~$2.3B
- Super alloys is third largest category, with a total value of $1.7B
- Composites and steel alloys are the next largest categories at approximately $1B each

Source: ICF SH&E
Aerospace Titanium Demand is Projected to Grow at an ~7% Annual Rate

Aluminum demand will continue to remain strong with the production of the 737RE coming on line in 2016

CFRP demand is anticipated to grow at 12% CAGR, followed by titanium alloys at 6.8% CAGR

Note composites increase at a lesser rate than metallics due to an extremely low buy to fly, typically less than 2 (where as metallics are 5-8 on average)

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* Adjusted for inventory overhang
** Includes aluminum-lithium as a small subset
Source: ICF SH&E
Titanium Demand Will Grow Fastest for Airframe Applications

Titanium Buy Weight Forecast
2011-2020, By System
(Fundamental Mill Demand)

Type, CAGR
- MRO; 2.2%
- Engine; 2.8%
- Airframe; 8.7%

Total CAGR = 6.8%
AEROSPACE INDUSTRY DYNAMICS – IMPLICATIONS FOR THE TITANIUM MARKET

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- Aerospace Production Outlook
- Titanium Demand Outlook

Key Trends
The Decisions By Boeing and Airbus to Re-Engine Single Aisle Aircraft is Negative for Titanium Demand

- American’s launch order for the B737 MAX coupled with the A320 NEO delays the introduction of high-titanium content single-aisle aircraft for at least a decade
- At the same time, there may be a drop in aggregate production rates as OEMs transition to new models mid-decade

**Implications For Titanium**
- ~30K lbs Ti (buy weight) per 737 MAX vs. versus ~90K of Ti on a new white sheet using B787 materials
- Loss for Titanium and gain for Aluminum!

Source: ICF SH&E
KEY TRENDS

Production Rates of the Joint Strike Fighter, a Key Titanium Consumer, Are at Risk

- Budget pressures and production problems have placed the JSF program is under increased scrutiny; the probability of full production rates before 2018 now unlikely
- The STOVL variant faces increased risk of being cancelled
- There is also risk of decreased international orders given EU budget pressures

Implications For Titanium
- JSF production rate projections have decreased considerably since 2010
- However, the JSF will comprise less than 2% of total aerospace Ti demand in 2016

Source: ICF SH&E
Key Messages

- Aircraft production rates are increasing because new, more fuel efficient aircraft are in demand
- Titanium Demand is increasing at 6.8% per year, driven by production increases as well as increased use of titanium in new aircraft

Key Trends:
- Boeing 737MAX decision is a loss for Titanium
- JSF program in flux but risk to Titanium is minor
- Positive production rates will continue to drive Titanium demand