Revenge of the Engine PMA

Jonathan M. Berger
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Alton Aviation Consultancy is a boutique aviation consulting firm with deep domain expertise across the aviation value chain.
Alton supports a global client base from offices in the U.S., Europe, China, Hong Kong, and Tokyo with additional associates worldwide.

**New York**
411 Fifth Avenue
Suite 801
New York, New York
10016
USA
+1 212 256 8488
New.York@AltonAviation.com

**Dublin**
No. 1 Grants Row
Lower Mount Street
Dublin, Ireland
+353 1 566 8933
Dublin@AltonAviation.com

**Beijing**
8 Guanghua Dongli
China Overseas Plaza
South Tower, Floor 11,
Suite A053
Chaoyang, Beijing 100020
China
+86 10 8598 4981
Beijing@AltonAviation.com

**Hong Kong**
136 Des Voeux Road
Suite 1202
Central
Hong Kong
+852 8191 3028
Hong.Kong@AltonAviation.com

**Tokyo**
Taiyo Seimei
Shinagawa building
28th Floor, 2-16-2 Konan,
Minato-ku, Tokyo 108-0075,
Japan
+81 90 8057 1956
Tokyo@AltonAviation.com

In China, Alton Aviation Consultancy is known as 德世国际航空咨询（北京）有限公司, or De Shi.
TODAY’S AGENDA

1. Alton Fleet & MRO Forecast
2. MRO Industry Trends
3. Revenge of the Engine PMA
Historically, fleet growth has been directly correlated to GDP…

### Fleet and GDP Growth by Region (1997 – 2017)

<table>
<thead>
<tr>
<th>Region</th>
<th>Avg. Fleet Growth/yr</th>
<th>Avg. GDP Growth/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>10%</td>
<td>4.4%</td>
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<tr>
<td>Asia-Pacific</td>
<td>7%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Africa</td>
<td>7%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Latin America</td>
<td>6%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Europe</td>
<td>5%</td>
<td>2.2%</td>
</tr>
<tr>
<td>North America</td>
<td>3%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

Source: CAPA, USDA ERS, Alton analysis
...perhaps a better determinant of future fleet growth is the so-called “Disneyland factor”; the growth rate of a country's middle class
Today’s commercial air transport fleet consists of approximately 28,000 aircraft, with Asia Pacific now equal in size to North America.

- **Narrowbody Jet**: 51% (8,400 aircraft)
- **Regional Jet**: 11% (6,600 aircraft)
- **Turboprop**: 9% (2,100 aircraft)
- **Widebody Jet**: 16% (2,100 aircraft)

Growing to 44,000 aircraft by 2028 at a 3.8% CAGR.
Today’s commercial air transport MRO market demand is approx. $69B, growing to $103B by 2028 – an annualized growth rate of 4.1%
THE CIRCLE OF LIFE
The circle of life…

“Farewell to the Queen”

C Series Aircraft Limited Partnership (CSALP)

“The C Series Resurrection…the A220”
THE YEAR AVIATION BLINKED
Is the airline industry really post-cyclical?

Global Airline Net Profit Margin

“"I don’t think we’re ever going to lose money again.”
“"We have an industry that’s going to be profitable in good and bad times.”
– Douglas Parker, American Airlines CEO, September 2017
“Policy matters…”: The United States is one of only two of the global destinations to see a decline in long-haul travel

Percent Change in Arrivals from 2015 to 2017

- United States (-6%)
- Canada 21.2%
- United Kingdom 17.5%
- Germany 8%
- France 4%
- Italy 2.2%
- Turkey (-6.7%)
- Saudi Arabia 20.3%
- United Arab Emirates 16.5%
- China 9.3%
- Thailand 13.9%
- Australia 22%

Estimated economic impact:
- $4.6B in lost spending
- 40,000 lost jobs

Source: US Travel Association, Bloomberg
“Policy matters…”: US in-bound market share fell in 9 out the top 10 international source markets

Percent Decrease in US International In-Bound Market Share from 2015 to 2017

Source: US Travel Association
Are interest rates the new fuel price?

**Alton Insight**

- **OEMs – Negative:** Customer financing costs increase; more difficult to sell new aircraft
- **MROs - Positive:** Used aircraft stay in service longer so volumes increase
- **Airlines - Neutral:** Inclined to retain more used aircraft; aircraft overall cost more to own and lease, so incremental less capacity
- **Lessors – Neutral:** Cost of financing increases; value of new aircraft incrementally less, value of used aircraft incrementally more
- **Parts Traders – Negative:** More difficult to source used aircraft
- **Financial Investors - Negative:** Value of outstanding bonds decline

**US Interest Rates: 2007 thru 2020**

Source: Federal Reserve, Alton analysis
THE POWER OF LITTLE DATA & THE EVOLUTION OF MRO
The MRO industry and aerospace supply chain continues to evolve driven by technological, commercial, and geopolitical events.

### Pre-Globalization
**Era of Self-Sufficiency**
- Airlines build/operate own maintenance facilities
- Aircraft and inventory owned, limited leasing
- Manufacturers with fully integrated supply chains
- Limited international airline networks
- Rise of LCCs and PBH agreements

### Globalization 1.0
**Era of Labor Cost Arbitrage**
- Outsourcing non-core competencies
- End of cold war
- Rise of the BRICS
- Open skies agreements
- NAFTA
- Global Financial Crisis
- Growth of the internet & advanced communications
- New oil/gas drilling technology
- Airline bankruptcies & consolidation

### Globalization 2.0
**Era of Machine Learning**
- U.S. energy revolution
- Global labor rate convergence
- Cloud computing
- Advanced prognostics & big data analytics
- Advanced manufacturing technology (robotics, automation, 3D printing)

**Source:** Alton Aviation Consultancy
lit·tle da·ta

*Noun: Little Data*

Definition: Life before “*Big Data*”…

Traditional, old school engineering design, innovation, entrepreneurship, and leadership
The aviation & MRO industry benefits of “Little Data” have been substantive and impressive

<table>
<thead>
<tr>
<th>Alton Insight</th>
<th>Then</th>
<th>Now</th>
<th>% Change</th>
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<tbody>
<tr>
<td>Engineering design and maintenance program development</td>
<td>1,700</td>
<td>59</td>
<td>97% ↓</td>
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<tr>
<td>Business model structure and strategy (e.g. creation of LCC)</td>
<td>6,000</td>
<td>25,000</td>
<td>416% ↑</td>
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<td>Supply chain innovation (e.g. use of surplus material and PMA, strategic sourcing, consignment programs, etc.)</td>
<td>380,000</td>
<td>320,000</td>
<td>16% ↓</td>
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<td>Commercial innovation (e.g. cost per flight hour programs for engines and components)</td>
<td>10,900</td>
<td>1,350,000</td>
<td>12,000% ↑</td>
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<td>Creative financing (e.g. sale-leaseback programs)</td>
<td>0.020</td>
<td>0.008</td>
<td>60% ↓</td>
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<td>Technical Dispatch Rate</td>
<td>99.20</td>
<td>99.80</td>
<td>0.6% ↑</td>
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INDUSTRY CONSOLIDATION
“A new golden age of aircraft cabin interiors”


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**Rockwell Collins acquires B/E Aerospace**
- $6.4bn transaction (and subsequent $30B UTC acquisition)
- Integration of seats, IFE, and onboard connectivity
- Expand cabin IoT capabilities

**Safran acquires Zodiac**
- $9bn transaction
- Create the world’s No.3 aerospace supplier
- Improve Zodiac’s production efficiency and customer satisfaction

**Airbus launches new subsidiary**
- Airbus Interiors Services (AIS)
- Three business lines:
  1. Tailored equipment (SFE and BFE)
  2. Upgrade solutions (cabin & connectivity)
  3. Innovative solutions

**Boeing forms aircraft seat joint venture**
- Joint venture with car seat manufacturer Adient
- Focus on reducing production delivery delays and aftermarket growth

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Source: Alton Analysis
Major aircraft OEMs and tier 1 suppliers continue to consolidate, vertically integrate, and partner/JV
A RISING TIDE LIFTS ALL CARGO AIRCRAFT
A rising tide lifts all cargo aircraft…
A rising tide lifts all cargo aircraft *(con’t)*

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<td>2010</td>
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<td>500</td>
<td>500</td>
<td>500</td>
<td>2000</td>
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**Alton Insight**

- “Amazon Air”, recently renamed from Amazon “Prime Air” to better distinguish the airline from its new drone-based delivery service
- The virtual cargo carrier’s current fleet consists of 40 Boeing 767s; in talks for additional P2F conversions and new freighters
- Amazon Air’s new $1.5B hub in Cincinnati International Airport (CVG) is projected to have capacity to handle approx. 100 freighters
- In Europe, Amazon utilizes a single Boeing 737-400(F) operated by ASL Airlines France in the UK, France, Spain, and Italy

Source: Source: Boeing, US Dept. of Commerce, FTI Consulting, Internet Retailer, China Daily, GB Times, China Xinhua, Alton Analyses
REVENGE OF THE ENGINE PMA
Current generation of narrowbody engines propelled the industry to new heights in aero-engine performance and reliability

**Alton Insight**

- From emissions, to noise, to time-on-wing & MTBR, the CFM56-5/7 and V2500 exceeded expectations on virtually every performance metric
- Many would argue the engines were too durable (shop visits driven by LLP, not EGT)
- Much to the delight of the MRO supply chain, the infamous shop visit “bow wave” has finally arrived, creating competition for shop visit slots

Source: Alton forecast
Annual deliveries of new technology engines will see dramatic increases, testing the scalability of the production supply chain.

**Alton Insight**

- Historically consistent, several new technology engines are experiencing operational “teething pains”, resulting in significant volume of unscheduled shop visits.
- CFM LEAP - turbine blade issues
- Pratt & Whitney PW1000G Geared Turbo Fan - knife-edge seals and cooling issues
- Rolls Royce Trent 1000 - fan blade issues

Source: Alton forecast
Fleet retirements are down from peak levels

**Alton Insight**

- Typical aircraft life is approx. 25 years; there was a large spike in aircraft deliveries in the late 1980’s.
- Airline retirement decisions are primarily driven by fuel prices and airline financial health.
- Surge in aircraft retirements spawned the aircraft tear-down/part-out industry; was very disruptive to OEM new parts sales.
- Growth of the used surplus material (USM) market had a significant impact on PMA growth.

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Source: CAPA, Alton analysis
Revenge of the Engine PMA: “The perfect storm”

1. New engine teething pains driving high volume of unscheduled shop visits
2. Mature engine routine shop visits at an all time high
3. Reduced retirements and part-outs limiting surplus part availability
4. Engine piece part supply chain unable to meet demand to support production and MRO

Industry Impact

1. Engine piece parts shortages (MRO and production)
2. Limited MRO slot availability
3. Engine shop visit TAT delays
4. New aircraft delivery delays
5. Lack of surplus engine material
6. Higher shop visit costs
7. Higher spare engine lease costs
8. Grounded aircraft (gliders)

Source: Alton analysis
Jonathan M. Berger: https://www.linkedin.com/pulse/revenge-engine-pma-jonathan-m-berger/