Alton Aviation Consultancy is a boutique aviation consulting firm with deep domain expertise across the aviation value chain.
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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. Global Fleet Dynamics & MRO Forecast
2. “Revenge of the Engine PMA”
3. New Engine Technologies on the Horizon
GLOBAL FLEET DYNAMICS & MRO FORECAST
Historically, fleet growth has been directly correlated to GDP…

Fleet and GDP Growth by Region (1997 – 2017)

- Middle East: 10% Fleet growth, 3.8% GDP growth
- Asia-Pacific: 7% Fleet growth, 4.4% GDP growth
- Africa: 7% Fleet growth, 4.2% GDP growth
- Latin America: 6% Fleet growth, 2.5% GDP growth
- Europe: 5% Fleet growth, 1.8% GDP growth
- North America: 3% Fleet growth, 2.2% GDP growth

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

Source: Airbus Global Market Forecast 2016-2036, Alton analysis
Record high OEM backlog continues to drive investor interest, joint venture, and M&A activity in MRO providers and OEM supply chain.
Over the past 25 years, the global fleet has grown at a rate of 4.9%, with narrowbody aircraft accounting for over 57% of today’s fleet.
Today’s commercial air transport fleet consists of approximately 28,000 aircraft, with Asia Pacific now equal in size to North America.

Growing to 44,000 aircraft by 2028

### Market Dynamics & MRO Forecast

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>2028 Forecast</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrowbody Jet</td>
<td>6,600</td>
<td>61%</td>
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<tr>
<td>Regional Jet</td>
<td>2,100</td>
<td>17%</td>
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<tr>
<td>Turboprop</td>
<td>1,300</td>
<td>14%</td>
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<tr>
<td>Widebody Jet</td>
<td>8,400</td>
<td>63%</td>
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### 2018-2028 Growth Rate

3.8% CAGR
Driven by narrowbody aircraft deliveries, the installed engine base in Asia-Pacific primarily consists of the CFM56-5/7 and V2500.

Installed Base by Engine Model

Installed Base by Country

Source: CAPA, Alton analysis
There are already over 4,400 confirmed orders for the CFM LEAP & P&W Geared Turbo Fan (GTF) engines in the APAC region

**Alton Insight**

- Both the CFM LEAP and P&W GTF are meeting fuel efficiency targets
- Given the recent Airbus / Bombardier venture, analysts predict a potential doubling of previous C Series/A220 order estimates (great news for P&W!)
- P&W has secured significant GTF MRO capacity in APAC via JVs with SAIEC (Eagle Services Asia in Singapore) and Air New Zealand (Christchurch Engine Center), IHI in Japan, and MTU Zuhai (China Southern JV)
- In APAC, GE plans to support the LEAP in its Singapore facility; MTU will also support the LEAP in its Zuhai, China facility

![10 Year Engine Count by Country](chart.png)
Today’s commercial air transport MRO market demand is approx. $69B, growing to $103B by 2028 – an annualized growth rate of 4.1%
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, challenging the scalability of the engine 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 - high pressure turbine shroud 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

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

## New engine teething pains driving high volume of unscheduled shop visits

## Mature engine routine shop visits at an all time high

## Reduced retirements and part-outs limiting surplus part availability

## 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/](https://www.linkedin.com/pulse/revenge-engine-pma-jonathan-m-berger/)
NEW ENGINE TECHNOLOGIES ON THE HORIZON
Additive manufacturing (or 3D printing) is already transforming traditional engine design and production

Alton Insight

▪ GE’s new Advanced Turboprop is being touted as “the world’s most printed engine”

▪ The Advanced Turboprop will power Cessna’s new Denali aircraft

▪ Additive manufacturing replaces 855 normally made parts with just 12 “printed” components

▪ GE claims the engine is designed to achieve 20% better fuel burn with 10% more power than comparative engines
An army of tiny robots are on the march; with plans to disrupt engine MRO inspection and repair processes

NEW ENGINE TECHNOLOGIES ON THE HORIZON

Alton Insight

- OEMs are developing very small robots which can venture inside an engine to perform inspections and carry out any necessary repairs.

- The robots are small enough to navigate their way around all the various fan and turbine blades, taking video of everything they see, and will relay the pictures wirelessly to technicians.

- Once the video has been analyzed by technicians, the robots will be able to carry out certain repairs (at the gate between flights!)