Big data; the race is on, but what is the end goal?

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Principal

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Agenda

- MRO trends
- Digital landscape
- Latest developments
- Summary
MRO trends
Global airline industry achieved a record profitability of $38B USD in 2017, but this is forecast to decrease to $33.8B in 2018.

Source: ICF/IATA analysis
…but many areas continue to struggle although North America has been a bright spot and was leading the way in 2017
Traffic growth, driven by low fuel prices, is slowly reversing as 2018 has shown YTD growth of ~6.0%

Air traffic growth rates increased from 5% annually to >7.5% … … but YTD growth limited at 6.0%

Fuel prices declined ~50%

Fuel edging back up

Jet fuel spot price ($ per gallon)

Air traffic annual growth rate

Source: EIA; IATA
Commercial aircraft OEM production backlog remains at historical highs

- Backlog more than doubled between 2010 and 2014, driven by:
  - Emerging market growth
  - Very low interest rates and plentiful capital
  - High oil and commodity prices
  - Introduction of new technology aircraft/engines

- In 2017, total backlog decreased for the first time since 2009 as deliveries ramp-up and orders slowdown
The current commercial air transport fleet consists of ~29,100 aircraft; ~8,500 are located in North America.

**By Aircraft Type**
- Narrowbody Jet: 55%
- Widebody Jet: 19%
- Regional Jet: 13%
- Turboprop: 13%

**By Region**
- North America: 29%
- Asia Pacific: 24%
- Europe: 24%
- Middle East: 7%
- Africa: 5%
- South America: 7%
The combination of strong air travel demand and the need to replace ageing aircraft will drive fleet growth at a healthy 3.1% p.a.

Fleet count

<table>
<thead>
<tr>
<th>Year</th>
<th>APAC</th>
<th>North America</th>
<th>Europe</th>
<th>Latin America</th>
<th>Middle East</th>
<th>Africa</th>
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</thead>
<tbody>
<tr>
<td>2017</td>
<td>8,449</td>
<td>8,495</td>
<td>7,087</td>
<td>2,116</td>
<td>1,586</td>
<td>1,360</td>
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<tr>
<td>2027</td>
<td>13,704</td>
<td>9,156</td>
<td>9,104</td>
<td>3,025</td>
<td>2,745</td>
<td>1,910</td>
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<tr>
<td>2037</td>
<td>46,878</td>
<td>9,592</td>
<td>10,094</td>
<td>3,822</td>
<td>3,328</td>
<td>2,561</td>
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</table>
2017 commercial air transport MRO demand is $75.5B; Asia is now larger than North America and Europe in market size

By MRO Segment
- Engines: 42%
- Components: 21%
- Line: 17%
- Airframe: 13%
- Modifications: 8%

By Region
- Asia Pacific: 30%
- North America: 27%
- Europe: 26%
- Middle East: 8%
- South America: 6%
- Africa: 4%

Source: ICF analysis
The global MRO market is expected to grow by 4.6% per annum to ~$118B by 2027

Source: ICF analysis
Asia continues to grow strongly and will generate 38% of MRO demand by 2037

Source: ICF analysis
North American MRO spend exhibits marginal growth, increasing by 1.7% per annum to $22.9B by 2027

Source: ICF analysis
Digital landscape
For the past three years, the digital race has accelerated in the MRO world across all type of players.
Several airlines are seeing the first tangible benefits of their aircraft health monitoring trials

<table>
<thead>
<tr>
<th>Results of Delta’s Predictive Maintenance approach</th>
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<tbody>
<tr>
<td>Avoided Engine Events</td>
</tr>
<tr>
<td>1,000 (over 1-year timespan)</td>
</tr>
</tbody>
</table>

**easyJet**

31 instances of Skywise correctly predicting faults before they occurred in service, allowing the carrier to intervene and remove components before they failed

**Cathay Pacific**

51% reduction

Cathay Pacific reduced APU-related delay minutes by 51% using Honeywell’s predictive maintenance trial program
There are nine primary phases within aircraft operations:

- Flight Planning ($0.6B)
- Pre-Take Off ($46B)
- Departure Taxi ($97B)
- En-route ($171B)
- Approach ($79B)
- Maintenance ($68B)
- Post Flight ($0.2B)
- Arrival ($20B)
- Landing ($20B)

Airline Operating Costs:

- Fuel 21%
- Employees 26%
- MRO 10%
- Aircraft lease 3%
- Depr. and amort. 6%
- Selling expenses 4%
- Airport & En-route 14%
- Others 16%

Source: ICF analysis
...the level of digitization across the nine categories varies

Key

- More digitised
- Less digitised

- Maintenance ($68B)
- Departure ($46B)
- Departure Taxi ($97B)
- En-route ($171B)
- Approach ($79B)
- Flight Planning ($0.6B)
- Arrival ($20B)
- Landing ($20B)
- Post Flight ($0.2B)

~$500B

Source: ICF analysis
In 2027 the air transport fleet will have approximately 17,000 “new technology” aircraft.

Source: ICF, excludes Turboprops
Note: Next-Gen Include: 737MAX, 747-8, 777X, 787(8,9,10), MoM, A319neo, A320neo, A321neo, A330neo, A350, C919, CSeries, Embraer E2s, SSJ100, MRJ90
Approximately 24,000 aircraft will be equipped with AHM by 2027

- New generation aircraft generate much more data compared to older types
- As data becomes increasingly useful to improve maintenance, the adoption of Aircraft Health Monitoring is expected to grow
- ICF expects ~24,000 aircraft will be equipped with Aircraft Health Monitoring by 2027 of which 17,000 are new technology aircraft
- This is driving a digitisation of aircraft operations, which will see high growth in the adoption of e-enabled services and further advances in health management
AHM can be viewed as a subset of data management value chain....

Aircraft Health Monitoring is inferring the state of the aircraft. 

Aircraft Health Management is extracting value from this information.

Aircraft Health Monitoring

Aircraft Health Management goes beyond predicting and replacing components, it incorporates flight operations and helps airlines in fleet and inventory management.

Acquisition & Synthesis
Transmission
Storage
Analysis
MRO Planning
MRO Action
Records Keeping

Diagnostics
Determining whether the component is performing its function

Prognostics
Predicting the remaining life of a component

Diagnostic
Troubleshoot while the aircraft is in flight or after it lands

Prognostic
Customise maintenance program to prevent unscheduled downtime
…consisting of building blocks essential to its implementation
For airlines, improved technical dispatch reliability and fewer NFFs are the key benefits of AHM

- ICF has quantified the savings into 4 categories:
  - **Technical Dispatch Reliability**: Maintenance related delays of over 15 minutes
  - **No Fault Founds**: Unnecessary removal of functional components
  - **Inventory**: Spare parts held by airlines/MROs
  - **Labor Productivity**: Labor costs during maintenance activities

- Through research and analysis, ICF found that improvements in NFFs and technical dispatch reliability bring the most savings from AHM

![Pie chart showing estimated breakdown of AHM benefits]
Latest developments
OEMs & MROs are embracing partnerships to cover the MRO data value chain

Source: ICF research
OEMs & MROs are embracing partnerships to cover the MRO data value chain

**Acquisition & Synthesis**
- AIRBUS
- **MRO Alliance**

**Transmission**
- BOEING
- Honeywell
- TELEDYNE
- ACARS / Gate Wi-Fi

**Storage**
- IBM
- Microsoft Azure
- BOEING
- BOEING
- BOEING

**Analysis**
- Palantir
- Lufthansa Technik
- AIRFRANCE INDUSTRIES
- AIRFRANCE INDUSTRIES
- ORACLE

**MRO Planning**
- AIRBUS
- BOEING
- Lufthansa Technik
- AIRFRANCE INDUSTRIES
- AAR

**MRO Action**
- ACARS / Gate Wi-Fi
- ORACLE
- ORACLE
- AAR
- AAR

**Records Keeping**
- AERDATA
- FLYdocs

Source: ICF research
The MRO industry has entered the ‘expand’ phase of the digital maturity lifecycle; numerous suppliers are developing digital tools that provide a solution for a single issue.

Source: ICF research
OEM’s are seeking new ways to expand their market share

- **Air Asia signed up for Skywise while under a component repair contract with AFI-KLM**
- **Airbus is likely to target other large (single) fleet operators next**
  - Economies of scale
  - Maximum return for the airline
  - Airbus gets closer to reaching critical mass for their platform

**Airbus seeks $10 bln annual commercial services revenue by 2025**

Reuters Staff
Summary
Digitisation could enable airlines to save in excess of $5B/year

- **Maintenance cost**
  ~ $3B
  From AHM and predictive maintenance
  - Driven by improved dispatch reliability, No Fault Found reduction, Inventory reduction and Improved labour productivity

- **Fuel saving**
  ~ $1.7B
  From flight optimisation
  - Continuous flight optimisation through live weather updates, speed and altitude optimisation...

- **Delay reduction**
  ~ $0.8B
  From improved operational processes
  - Improved turnaround process, in-flight routing optimisation
But there are a number of key questions Airlines, OEMs and MROs need to evaluate

- Are the basics in place to exploit data? Are your shop findings in a database format?
- Will digitisation break the borders between the different players in the aviation market?
- Will digitisation allow the outsourcing of currently “core” airline activities?

Digitisation offers airlines the potential for efficiency that is only just being understood. Suppliers need to create the right partnerships & value propositions.

Where OEMs have previously focused their Services M&A efforts on R&O investments, focus is now on acquiring IT expertise.

Non aviation incumbents are disrupting the markets (e.g. Amazon in the cargo market)
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