Oliver Wyman’s Aviation, Aerospace & Defense practice is the largest and most comprehensive consulting team dedicated to the industry

**OUR EXPERIENCE**
- ~450 professionals across Europe, North America and Asia
- Deep aviation knowledge and capabilities allow the practice to deliver data-driven solutions and provide strategic, operational, and organizational advice

**OUR CLIENTS**
We have worked with more than 75% of the industry’s Fortune 500 companies, including:
- Most Global Airlines
- MROs, OEMs, and independent parts suppliers in the Americas, Europe, and Asia
- Dominant aerospace and defense firms

**OUR APPROACH**
- **Data-driven**: Unbiased benchmarking and forecasting tools to establish problems and identify solutions
- **Innovative**: Ideas that are forward-thinking
- **Actionable**: Results-oriented recommendations
- **Collaborative**: An emphasis on working with our clients, alongside executives, management, and support teams
This presentation incorporates Oliver Wyman’s 2019–2029 Global Fleet & MRO Market Forecast and 2019 MRO Survey, both of which are available at oliverwyman.com
State of the Industry
The global economy and aviation has come a long way from the 2008 Great Recession

A Look Back at the 2008 Financial Crisis

Annual Fleet Size Europe vs Rest of World Count of Aircraft

Global fleet growth has fueled MRO…but 10 years without a downturn, is this trend sustainable?

Source: Oliver Wyman Historical Analysis

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Global RPKs are forecast by Boeing to grow 4.7 percent annually over the next two decades, outpacing global GDP growth of 2.8 percent over the same period.

2017-2037 Year RPK and GDP Growth Projections
Source: Boeing

Source: IATA, Air Travel Demand Briefing, April 2018
The global middle economic group is expected to add over 1.8 billion people over the next decade plus

Global Middle and Upper Economic Group Population Growth

Billions of people

<table>
<thead>
<tr>
<th>Year</th>
<th>RPKs</th>
<th>5.8% CAGR</th>
<th>Aircraft</th>
<th>3.3% CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>6.6T</td>
<td></td>
<td>23,600</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>7.7% CAGR</td>
<td>3.7% CAGR</td>
<td>26,300</td>
<td>3.6% CAGR</td>
</tr>
<tr>
<td>2030</td>
<td>8.3T</td>
<td>5.2% CAGR</td>
<td>40,000</td>
<td>12.6T</td>
</tr>
</tbody>
</table>

By 2030, 40,000 aircraft will be needed to provide 12.6T RPKs annually

Source: Brookings, UN, IATA
Europe 2018 profits were largely unaffected despite increases in both fuel and labour costs.

Global Commercial Air Transport Industry Net Profit and Fuel Prices
By year

Representing almost a quarter of operating expenses, the global airline industry had an estimated $180B in fuel costs during 2018. Fuel will always be essential to Airline margin quality.

Source: IATA, US Energy Information Administration
Over last year, the global commercial in-service fleet grew 4.5 percent, driven by a slowdown in aircraft removals.

Year Over Year Changes to the Global Commercial Air Transport Service Fleet:

- **26,307** 2018 In-Service Fleet
  - Sent to Storage: **1,045**
  - Formally Retired: **130**
  - Involved in an accident: **37**
  - Stored for Conversion: **29**
  - Transferred to non commercial operator/unknown: **5**

- **2,427** Aircraft Additions
  - New Aircraft Delivery: **1,687**
  - Removed from Storage: **665**
  - Completed freighter conversion: **69**
  - Transferred from non commercial operator: **6**

- **27,492** 2019 In-Service Fleet

2019 Global Commercial Air Transport MRO Market Forecast:

- Engine: **4.1%**
- Component: **4.3%**
- Line: **3.9%**
- Airframe & Modifications: **1.7%**

Translating the global fleet dynamics into MRO spend, the 2019 market is expected to be **$81.9B**, with engine MRO continuing to be the single largest expense category.
By 2029, the global fleet will grow by nearly 12,000 aircraft, pushing commercial MRO spend up to $116B

By 2029, next generation aircraft will represent over half of total MRO spend, up from 13 percent today

Source: Oliver Wyman Global Commercial Air Transport Fleet Forecast; Scenario variables: Economic growth, passenger traffic, fuel prices and interest rates

1. 2010 vintage and later

© Oliver Wyman
The European fleet and related MRO spend are set to grow at 2.4 percent annually over the next 10 years

Europe Global Commercial Air Transport Fleet Forecast
By Aircraft Class/number of Aircraft

Europe Global Commercial Air Transport MRO Forecast
By Aircraft Class/US$ BN

Source: Oliver Wyman Global Commercial Air Transport Fleet Forecast

© Oliver Wyman
From a region perspective, Western Europe is fueling the majority of the growth.

**Europe Global Commercial Air Transport Fleet Forecast**
By Region Segment/number of Aircraft

- **CAGR 2019-2024**
  - Eastern Europe: 2.6%
  - Western Europe: 2.6%

- **CAGR 2024-2029**
  - Eastern Europe: 2.3%
  - Western Europe: 2.8%

**Europe Global Commercial Air Transport MRO Forecast**
By Region Segment/US$ BN

- **CAGR 2019-2029**
  - Eastern Europe: 2.1%
  - Western Europe: 2.0%

**Source:** Oliver Wyman Global Commercial Air Transport Fleet Forecast
European deliveries will be very skewed to Narrowbody aircraft which will dominate the future MRO market.

Three Decades of Narrowbody Growth
Share of Europe fleet, %

<table>
<thead>
<tr>
<th>Year</th>
<th>Narrowbody</th>
<th>Widebody</th>
<th>Regional Jet</th>
<th>Turboprop</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>49%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>58%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>62%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2029</td>
<td>69%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost Advantages
- Fuel efficiency
- Cost of acquisition and financing
  - Large block commitments of aircraft
  - Large lessor inventory of NB jets

Maintenance Advantages
- Programme synergies with previous models
  - Designed to incorporate maintenance programmes with close similarities to previous generations
- Maintenance base locations and capabilities
  - Providers with prior NB capabilities able to expand to newer generations
  - Wide range of available locations to perform maintenance

Operations Advantages
- Gate availability
  - Most airport gates are built for wingspans between 75ft (RJs) and 120ft (NBs) where WB wingspans reach 220 ft
- Route density
- Range flexibility
- Pilot familiarity
- Shrink or stretch models
  - Seat ranges from 150-200+

1. 2010 vintage and later
2 Downturn on the Way?
In the short term, various global risks could impact the growth of the commercial fleet and MRO demand.

- Labour Shortage
- Brexit
- Fuel Prices
- Rising Interest Rates
- Global Trade Wars
Passenger demand, fuel costs and supply chain capacity are the three most impactful factors from the 2019 Survey.

Over the next five years, which three factors are most likely to determine the direction of the MRO market?

% of participants who selected each response:

- Passenger Demand: 54%
- Jet Fuel Costs: 53%
- Manufacturing and/or supply chain capacity: 53%
- Labour costs/labour relations: 45%
- Political Conditions: 29%
- Trade Relations: 18%
- Other: 14%

Slowing or declining passenger demand will be a concern equally for OEMs, operators and MROs.
Despite potential risks, more than 90% of respondents believe the aftermarket will grow over the next five years.

Over the next five years, in the regions you operate, do you expect to see demand (spend) for MRO services to...
Out of 13 possible options, likely actions in response to a downturn were focused amongst five options.

Please select the top three levers you will likely use in the event of an economic downturn.

Distribution of total responses:

<table>
<thead>
<tr>
<th>Action</th>
<th>Non-operators</th>
<th>Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Headcount</td>
<td>17%</td>
<td>68%</td>
</tr>
<tr>
<td>Introduce Operational Efficiency Measures</td>
<td></td>
<td>64%</td>
</tr>
<tr>
<td>Re-negotiate existing agreements with vendors and suppliers</td>
<td>32%</td>
<td>55%</td>
</tr>
<tr>
<td>Reduce, postpone or cancel planned expansions or innovations</td>
<td>47%</td>
<td>51%</td>
</tr>
<tr>
<td>Parking/Storing/Cannibalization of Aircraft</td>
<td>43%</td>
<td></td>
</tr>
</tbody>
</table>

While non-operators would plan to reduce headcount, aircraft operators would largely maintain staffing levels, choosing to improve efficiency and temporarily decrease capacity through postponements and storing aircraft.
The responses align with history; e.g. the amount of stored aircraft saw large spikes in 2002 and 2009.

Annual Fleet Removals from Service and New Deliveries
Number of Aircraft

With an average age of 18 years, aircraft sent to storage would not incur scheduled maintenance events, negatively impacting MRO demand in the short term.
3 An OEM Centric Aftermarket
In 2018, there was an expectation that OEM’s would see an increase in market share, driven by three key factors.

Compared to the market growth, OEMs’ share of the aftermarket over the next 3 years will...

- Increase significantly more rapidly: 38%
- Increase slightly more rapidly: 40%
- Increase about the same: 7%
- Increase slightly less rapidly: 10%
- Increase significantly less rapidly: 5%

How will OEM grow their presence in the aftermarket?
Weighted average of rankings (scale of 1-3)

- Usage restrictions on existing IP and licensing: 2.1
- Joint ventures with existing MROs and suppliers: 1.7
- M&A: 1.5
- New internal start-ups: 0.2
- Other: 0.2
In 2019, respondents continue to believe that OEMs will grow in the aftermarket space

Q: Over the next couple of years, what is the likelihood of the following events happening in aftermarket services?

Distribution of total responses

<table>
<thead>
<tr>
<th>Event</th>
<th>Highly likely</th>
<th>Likely</th>
<th>Unlikely</th>
<th>Highly unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine OEMs will develop more capabilities through acquisitions of Tier 1 or 2 OEMs</td>
<td>56%</td>
<td>43%</td>
<td>24%</td>
<td>3%</td>
</tr>
<tr>
<td>Airframe OEMs will develop more capabilities through acquisitions of Tier 1 or 2 OEMs</td>
<td>39%</td>
<td>44%</td>
<td>14%</td>
<td>3%</td>
</tr>
<tr>
<td>Consolidation with service providers (MROs)</td>
<td>32%</td>
<td>53%</td>
<td>13%</td>
<td>1%</td>
</tr>
<tr>
<td>Consolidation within Tier 1 players</td>
<td>30%</td>
<td>55%</td>
<td>13%</td>
<td>2%</td>
</tr>
<tr>
<td>Consolidation across different types of players (Airframe / Engine / Tier 1 OEMs / service…)</td>
<td>25%</td>
<td>43%</td>
<td>24%</td>
<td>4%</td>
</tr>
<tr>
<td>Consolidation within distributors</td>
<td>37%</td>
<td>51%</td>
<td>11%</td>
<td>1%</td>
</tr>
</tbody>
</table>

95 percent of respondents believe that Airframe OEMs will develop more capabilities either internally, through joint ventures or acquisitions of Tier 1/2 OEMs
Growing demand for USM offerings is changing the spare parts aftermarket and helping improve penetration rates.

As older vintages are retired over the next five years, what will be the most important result of this for the aftermarket?

- Pivot to new aircraft types for MRO: 39%
- Surplus of new parts from aircraft tear-down: 37%
- Reduced short term MRO Demand: 14%
- Other: 6%

Operators are not waiting for the market to meet their materials needs, as cost advantages for USM parts / DER repairs are driving increased demand in the segment. By 2029, USM, PMA and DER/PRP will represent close to 50 percent of all engine materials.
3

A Digital Evolution
Cost ranks as the most important selection factor for MRO supply, with almost 90 percent ranking it in their top 5

**What are the most important factors when an operator is choosing an MRO service provider?**

Ranking each factor from 1 (most important) to 13 (least important) - % of respondents

- **Cost**: 38% (Ranked 1)
- **Quality and consistency in service**: 31% (Ranked 2)
- **On-time performance**: 9% (Ranked 3)
- **Expertise**: 8%
- **Turnaround time**: 5%
- **Long-term Relationship**: 4% (Ranked 1)
- **Geographic proximity**: 3% (Ranked 2)
- **Access to data**: 3%
- **Bundling product purchase and aftermarket services with single provider**: 2%
- **Breadth of offering**: 2%
- **Technology/access to OEM**: 2%
- **Data and analytics services provided by an MRO**: 1%
- **Other**: 40%

Currently, digital and data analytics offerings are not a differentiator when choosing an MRO service provider.

© Oliver Wyman
While not considered the most important factor, digital offerings have evolved with benefits expected soon.

**What digital offerings have evolved the most?**

<table>
<thead>
<tr>
<th>Offering</th>
<th>% of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance planning and predictive maintenance</td>
<td>66%</td>
</tr>
<tr>
<td>Aircraft health management</td>
<td>65%</td>
</tr>
<tr>
<td>Business intelligence and data analytics</td>
<td>51%</td>
</tr>
<tr>
<td>Data and services platform creation</td>
<td>29%</td>
</tr>
<tr>
<td>Flight operations efficiency and decision making support</td>
<td>28%</td>
</tr>
</tbody>
</table>

**When is each digital offering likely to benefit your business the most?**

<table>
<thead>
<tr>
<th>Offering</th>
<th>Distribution of total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance planning and predictive maintenance</td>
<td>In the near term (3 years): 76%</td>
</tr>
<tr>
<td></td>
<td>In the long term (10 years): 21%</td>
</tr>
<tr>
<td>Aircraft health management</td>
<td>In the near term (3 years): 65%</td>
</tr>
<tr>
<td></td>
<td>In the long term (10 years): 29%</td>
</tr>
<tr>
<td>Business intelligence and data analytics</td>
<td>In the near term (3 years): 61%</td>
</tr>
<tr>
<td></td>
<td>In the long term (10 years): 35%</td>
</tr>
<tr>
<td>Data and services platform creation</td>
<td>In the near term (3 years): 41%</td>
</tr>
<tr>
<td></td>
<td>In the long term (10 years): 49%</td>
</tr>
<tr>
<td>Flight operations efficiency and decision making support</td>
<td>In the near term (3 years): 53%</td>
</tr>
<tr>
<td></td>
<td>In the long term (10 years): 31%</td>
</tr>
</tbody>
</table>
AHM technology has evolved over the past two decades, driving increased adoption rates among operators.

- **2001**: Airbus launches AIRMAN software tool
- **2002**: Boeing begins development of AHM system
- **2003**: Air France, Japan Airlines, and American Airlines test Boeing Airplane Health Management
- **2004**: Singapore Airlines becomes first customer of Boeing AHM
- **2005**: Continuous data streams
  - Preventative maintenance tasks
  - Predictive capabilities
  - Portable Maintenance Aid
- **2007**: US Airways becomes largest user of AIRMAN with over 200 aircraft
- **2011**: Automated monitoring of fuel consumption and CO2 emissions
  - Performance monitoring module
- **2014**: Southwest implements Boeing AHM on existing 737 NG fleet
- **2015**: Connectivity systems
  - Graphical User Interface
  - Engine Indicating and Crew Alerting System
  - Predictive enhancements
- **2017**: Airbus launches Skywise in collaboration with Palantir
  - Boeing launches AnalytX
- **2019**: 600,000 data occurrences within 0.1s
  - Contextualize sensor data against PFRs
  - Worldwide maintenance and engineering data available for benchmarking
  - Machine learning and neural networks
- **2018**: WestJet becomes 100th customer for Boeing AHM

**Technology Adoption**

**Descriptive**
- ACARS & ACMS
- Troubleshooting
- Preventative maintenance tasks
- Fault data reporting

**Predictive**
- Continuous data streams
- Predictive capabilities
- Portable Maintenance Aid
- Automated monitoring of fuel consumption and CO2 emissions
- Performance monitoring module
- Connectivity systems
- Graphical User Interface
- Engine Indicating and Crew Alerting System
- Predictive enhancements

**Prescriptive**
The AHM/PM field has become increasingly crowded over the past two decades
Disagreements exist about who should provide these digital services like AHM and predictive maintenance planning.

Who should be responsible for providing digital and data analytics services?

Distribution of total responses by company type:

- **MRO**
  - BI & Data analytics: 33%
  - MX planning and PM: 13%
  - AHM: 8%
  - Data and services platform creation: 8%
  - Flight ops efficiency & decision making support: 42%

- **OEM**
  - BI & Data analytics: 42%
  - MX planning and PM: 17%
  - AHM: 17%
  - Data and services platform creation: 8%
  - Flight ops efficiency & decision making support: 67%

- **Operator**
  - BI & Data analytics: 49%
  - MX planning and PM: 5%
  - AHM: 33%
  - Data and services platform creation: 5%
  - Flight ops efficiency & decision making support: 26%
And finally….Hot Topics and Conclusions
Aside from those already discussed, other hot topics will be high on the MRO Europe agenda this week…

- More European airline consolidation and exits?
- The Environment issue…an existential threat? A European only issue? Timing?
- 737 Max impact?
- Brexit ???
Conclusions

Fleet and MRO growth is supported by strong underlying metrics

- An expanding global middle class will drive demand for air travel over the next decade plus
- Emerging markets will see the largest growth on a relative basis
- The global fleet will exceed 39,000 aircraft by 2029, driving $116B in MRO demand

Aftermarket battles will intensify, driven by an expanded OEM presence along with the increasing popularity and availability of USM materials and repairs

- An acceleration of aircraft retirements in developed regions will replenish the shrinking supply of used parts
- Industry acceptance of alternate materials sources will increase competition in the aftermarket

Despite near term global risks, the industry is bullish about both short and long-term growth potential

- Tightening labour conditions, fuel prices, global trade wars and political instability are all external factors that could negatively affect market growth
- Future sentiment is largely positive, with plans in place to deal with a potential downturn

Digital offerings will continue to evolve and positively impact the bottom line

- Mx planning, AHM and predictive maintenance have evolved the most
- As these offerings begin to impact cost more substantially, they will become important factors considered by operators when choosing an MRO