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

**OUR EXPERIENCE**
- 250 plus professionals across Europe and North America
- Deep aviation knowledge and capabilities allow the practice to deliver data-driven solutions and provide strategic, operational, and organizational advice
- Increased technical aviation expertise in Europe from 2017 acquisition of UK-based AVISA Aviation Safety Systems

**OUR CLIENTS**
We have worked with many of the industry’s Fortune 500 companies, including
- All major North American airlines
- Leading MROs, OEMs, and independent parts manufacturers in the Americas, Europe, and Asia
- 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 2018–2028 Global Fleet & MRO Market Forecast and 2018 MRO Survey, both of which are available at www.OliverWyman.com/MROSurvey2018
1 Industry Overview
Global performance remains strong with North American operators continuing to deliver positive financial performance

Continued growth in revenue from ancillaries, widespread capacity discipline, and a lack of new entrants are helping the North American operators offset the impact of shifting economics

Source: IATA
As oil prices rebound, operators will face new cost pressures, particularly with the older generation widebody aircraft.

**Crude Oil and Jet Fuel Spot Prices per Gallon**

*By year / US$ BN*

- New gen narrowbody aircraft are more profitable than current gen.
- New gen widebody aircraft are more profitable than current gen.

*Source: U.S. Energy Information Administration, Oliver Wyman Analysis*
Over the past year, status changes to 3,613 aircraft have lead the global in-service fleet to experience growth of 939 aircraft.

Year Over Year Changes to the Global Commercial Air Transport In-Service Fleet
By Transaction Type

- **25,368** Aircraft Removals: 2017 In-Service Fleet
  - 1,337 Storage for conversion into a freighter
  - 3 Transferred to a non-commercial operator
  - 16 Involved in an accident
  - 115 Formally retired
  - 1,185 Sent to storage
- **2,276** Aircraft Additions: Transferred to a commercial operator
- **26,307** 2018 In-Service Fleet
  - 1,629 New aircraft delivery
  - 608 Removed from storage
- 3 Completed freighter conversion

2018 Global Commercial Air Transport MRO Market Forecast
By MRO Segment

- **$19.0 BN** Airframe & Modifications
- **$32.7 BN** Engine
- **$12.9 BN** Component
- **$12.8 BN** Line

Translating the changing fleet dynamics into MRO, the 2018 market is forecast to be $77.4B, with engine MRO continuing to be the driver of growth.
Though the global fleet & MRO market are expected to increase nearly 50% by 2028, increasing costs (e.g., oil prices) & external market factors (e.g., interest rates) create considerable uncertainty for realized growth.

A extended trade war between the US and large trading partners such as China and Europe would likely drive the forecasts to the lower bounds and shave several years of growth off the industry’s potential.
The global fleet is forecast at an annual growth rate of 3.7%, while the MRO market is forecast to grow at an annual rate of 4.5%.

Next gen narrow body aircraft will dominate the global fleet growth, while expensive engine shop visits associated with more fuel efficient technologies will drive the growth in the MRO market.

Source: Oliver Wyman Global Commercial Air Transport Fleet Forecast
North America is forecast to experience very moderate growth of 1.5%, reaching a fleet size of just over 9,000 aircraft by 2028.

### North America Commercial Air Transport Fleet Forecast

**By Aircraft Class / number of Aircraft**

<table>
<thead>
<tr>
<th>Year</th>
<th>Narrow-body</th>
<th>Wide-body</th>
<th>Regional Jet</th>
<th>Turbo-prop</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>7,830</td>
<td>1,5%</td>
<td>-3.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>'18–'23</td>
<td>-3.6%</td>
<td>-1.0%</td>
<td>3.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>CAGR</td>
<td>8,430</td>
<td>1.4%</td>
<td>-3.9%</td>
<td>2.7%</td>
</tr>
<tr>
<td>'23–'28</td>
<td>-3.9%</td>
<td>-0.8%</td>
<td>2.7%</td>
<td>2.8%</td>
</tr>
<tr>
<td>CAGR</td>
<td>9,047</td>
<td>1.5%</td>
<td>-3.7%</td>
<td>2.2%</td>
</tr>
<tr>
<td>'18–'28</td>
<td>-3.7%</td>
<td>-0.9%</td>
<td>2.2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>CAGR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### North America Commercial Air Transport MRO Forecast

**By MRO Segment / US$ BN**

<table>
<thead>
<tr>
<th>Year</th>
<th>Airframe and Mods</th>
<th>Engine</th>
<th>Component</th>
<th>Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>$20</td>
<td>$19</td>
<td>$24</td>
<td>$24</td>
</tr>
<tr>
<td>'18–'23</td>
<td>-0.5%</td>
<td>4.2%</td>
<td>1.8%</td>
<td>2.0%</td>
</tr>
<tr>
<td>CAGR</td>
<td>2.1%</td>
<td>9.2%</td>
<td>2.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>2023</td>
<td>$20</td>
<td>$19</td>
<td>$24</td>
<td>$24</td>
</tr>
<tr>
<td>'23–'28</td>
<td>-3.3%</td>
<td>-3.3%</td>
<td>-0.5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>CAGR</td>
<td>-3.3%</td>
<td>-3.3%</td>
<td>-0.5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>2028</td>
<td>$24</td>
<td>$24</td>
<td>$24</td>
<td>$24</td>
</tr>
<tr>
<td>'18–'28</td>
<td>1.8%</td>
<td>4.2%</td>
<td>2.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>CAGR</td>
<td>4.2%</td>
<td>2.7%</td>
<td>1.7%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

While North America MRO spend is expected to decline over next 5 years, it is expected to grow faster in the following 5 years, leading to an overall 1.8% annual growth rate between 2018–2028.

Source: Oliver Wyman Global Commercial Air Transport Fleet Forecast
The industry’s OEM preoccupation
As has been the case for the past few years, survey respondents are concerned about increasing OEM presence in the aftermarket.

Will OEMs’ increasing presence in the aftermarket fundamentally change your market?

Distribution of total responses:
- Yes: 71%
- No: 29%

Segment deep dive:

- MROs: 36% Yes, 64% No
- Operators: 30% Yes, 70% No
- OEMs: 56% Yes, 44% No

Interestingly, OEMs themselves are less convinced about their impact in fundamentally changing the aftermarket.

© Oliver Wyman
This year’s survey indicates that 75%+ of respondents see OEMs as credible in their ambitions.

Do you think OEMs’ growth targets for their aftermarket business units are achievable within the next decade?

- Yes: 12%
- No, but they will come close: 63%
- No, they will miss their goal by a wide margin: 24%

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%
OEMs are expected to leverage the strength of their IP positions to increase share of the aftermarket in the near term.

How will OEM grow their presence in the aftermarket?

Weighted average of rankings (highest to lowest ranking, scale of 3 - 1)

- Usage restrictions on existing IP and licensing: 2.1
- Joint ventures with existing MROs and suppliers: 1.7
- M&A: 1.5
- New internal startups: 0.2
- Other: 0.2

Who is the (majority) owner of the IP your current aftermarket service offering depends on?

Distribution of total responses

- A non-OEM company owns the IP: 6%
- My company owns the IP: 24%
- An OEM owns the IP: 70%

© Oliver Wyman
And only the OEMs are comfortable with their IP ownership position; third party MROs clearly feel the most vulnerable.

Do you own enough of the IP or OEM authorized licensing to continue to be successful if an OEM restricts use of the IP they own or licenses they provide?

**Distribution of responses**

- **Yes:** 38%
- **No:** 42%
- **No opinion:** 20%

**Segment deep dive**

**Distribution of responses for each segment**

- **MROs**
  - Yes: 18%
  - No: 32%
  - No opinion: 50%

- **Operators**
  - Yes: 20%
  - No: 40%
  - No opinion: 40%

- **OEMs**
  - Yes: 11%
  - No: 89%
  - No opinion: 0%
2b | Dealing with rising costs
Almost all respondents report experiencing increasing material costs

Have you experienced an increase in material costs?

Distribution of responses

- Yes: 97%
- No: 3%

Main drivers of material cost increases (for yes responses)

Weighted average of rankings (highest to lowest ranking, scale of 5 - 1)

- Annual OEM material price increases: 3.8
- OEMs restricting the direct sale of OEM designed parts: 2.6
- Next generation aircraft: 1.7
- Lack of availability of USM: 1.5
- Supply chain failures/issues: 1.2
- Other: 0.2
However respondents have no single dominant strategy to combat rising material costs

What strategy or strategies have you adopted or are you considering to combat rising material costs?

% of respondents who selected each response (for top 5 strategies only)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner with OEM to secure discounts</td>
<td>60%</td>
</tr>
<tr>
<td>Leverage data analytics, aircraft health monitoring and predictive maintenance to reduce material usage</td>
<td>51%</td>
</tr>
<tr>
<td>Increase overall usage of USM parts from any source</td>
<td>50%</td>
</tr>
<tr>
<td>Implement policy to use own USM rather than purchasing parts when able</td>
<td>47%</td>
</tr>
<tr>
<td>Implement policy to use alternative parts rather than purchasing OEM parts when able</td>
<td>41%</td>
</tr>
</tbody>
</table>
An increase in USM from a small base is expected; however, lack of supply and lack of a clear sourcing strategy are big inhibitors.
On the labor front, not surprisingly, W Europe is the highest technician bill rate region, E Europe and N America are on par, with all other regions substantially lower.
And globally, respondents overwhelmingly indicate that a lack of labor supply is the primary driver of wage increases by a factor of two.

Have you experienced any upward technician wage pressure?

Main drivers of technician wage pressure (for yes responses)

Distribution of total responses

Weighted average of rankings (highest to lowest ranking, scale of 5 - 1)

- Lack of labor supply: 4.3
- Inflation: 2.3
- Globalization: 2.0
- Unions: 2.0
- Political volatility: 0.4
- Other: 0.1

Technician retirements and a lack of new technician creation continue to squeeze both ends of the workforce spectrum – a trend that is unlikely to be resolved soon.
Combatting rising labor costs: many strategies are being considered by Operators, MROs and OEMs

**What strategy or strategies have you adopted or are you considering to combat rising labor costs?**

% of respondents who selected each response

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement job sharing, lean, and other internal productivity and efficiency strategies</td>
<td>59%</td>
</tr>
<tr>
<td>Leverage data analytics, aircraft health monitoring, and predictive maintenance to reduce labor demand</td>
<td>59%</td>
</tr>
<tr>
<td>Increase the use of technology (i.e automation, drones and robots) to reduce labor demand</td>
<td>57%</td>
</tr>
<tr>
<td>Establish an internal maintenance technician training program (e.g. Part 147) or partner with an existing program to combat labor supply issues</td>
<td>47%</td>
</tr>
<tr>
<td>Outsource work to lower cost facilities and/or regions</td>
<td>44%</td>
</tr>
<tr>
<td>Leverage engineering capabilities by developing DER repairs and modified work scopes</td>
<td>39%</td>
</tr>
</tbody>
</table>
Training programs are seen as a key to improving labor productivity, but a large gap between importance and satisfaction exists.

Difference between average importance ranking vs. average satisfaction ranking
Rankings on a scale of 0 to 10; rankings of importance and satisfaction made separately

- Addresses compliance / regulatory requirements
- Drives improvements in maintenance quality
- Reduces maintenance costs
- Is customized to meet individual’s training needs
- Delivers practical training (vs classroom / theoretical)
- Uses modern technology (e.g. eLearning, Apps, demos)
- Shares learnings from one location to other locations
- Has a measurable ROI associated with it
Cybersecurity
Every day and across every facet of life, hackers are increasingly bolstering capabilities to launch cyberattacks and disrupt industries.

Nature of cyber threats has evolved drastically over just the past decade.

Experts place the number of expert, professional hackers at over 300,000 globally.

Hackers use a variety of means to achieve a number of ends.

Global counter-hacking efforts and actual damages are estimated at half a trillion US$ annually.
67% of respondents indicate they believe that they are prepared, yet less than half had conducted a review of cybersecurity risk in 2017.

Is your company well prepared to handle cybersecurity threats related to operations and maintenance?

Has your company conducted a review of your cybersecurity risk in operations and maintenance in 2017?

Distribution of total responses

- 67% Yes
- 33% No
- 19% Unknown

Distribution of total responses

- 47% Yes
- 34% No
- 19% Unknown
A chain is only as strong as its weakest link; stolen credentials have lead to multiple, significant breaches

<table>
<thead>
<tr>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Target** (2013)                    | - Hackers used stolen credentials of a Target vendor to penetrate Target’s network  
  - Planted Russian-coded malware and stole personal data of 70 MM customers and information on 40 MM payment cards  
  - Cost to Target: ~$300 MM                                                                  |
| **Third-party vendor** (2014)        | - Hackers stole log-on credentials – used to steal data from 56 MM credit and debit cards and 53 MM customer emails  
  - Cost to vendor: $180 MM+                                                                 |
| **Global Infrastructure attack** (2017) | - Hackers attacked the Ukraine with wiper malware (NotPetya)  
  - Wiped out data and disrupted operations across industries (banking, transportation, energy)  
  - Spread to computer systems around the world after computers at the Danish shipping conglomerate Maersk were infected (cost to Maersk: $300 MM)  
  - Led to serious delays in major ports (e.g. Rotterdam, Port of New York and New Jersey); temporary shutdown largest terminal at the port of Los Angeles |
The MRO industry has not yet had a major Target or Equifax level cyber-attack – are we next?
Oliver Wyman believes three factors make the MRO industry a prime candidate for a major cyber attack

1. Industry players have access to the networks of world’s airlines and OEMs
   • Any business in this supply chain becomes target

2. MRO providers operate across the globe
   • MRO companies more vulnerable to regional disparities in security
   • Attractive for hackers looking to cause maximum, cross-border disruption

3. Industry is becoming increasingly digitized
   • More interconnectivity, more access points (e.g. Internet of Things), more direct third-party participation
   • Difficult to control for all the hands that can come in contact with multitude of processes, systems & data
While the majority of companies show an appropriately elevated level of concern, the survey reveals considerable variability in levels of preparedness.

### Which cybersecurity safeguards has your company implemented?

**% of total respondents who selected each response for each segment**

<table>
<thead>
<tr>
<th>Security Measure</th>
<th>Overall</th>
<th>MROs</th>
<th>OEMs</th>
<th>Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall cybersecurity strategy for the company</td>
<td>68%</td>
<td>64%</td>
<td>50%</td>
<td>90%</td>
</tr>
<tr>
<td>Employee cybersecurity training program</td>
<td>49%</td>
<td>49%</td>
<td>55%</td>
<td>62%</td>
</tr>
<tr>
<td>Security standards for third party vendors</td>
<td>39%</td>
<td>50%</td>
<td>41%</td>
<td>50%</td>
</tr>
<tr>
<td>Cybersecurity threat assessment</td>
<td>35%</td>
<td>41%</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td>Active monitoring of cybersecurity intelligence</td>
<td>30%</td>
<td>41%</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td>Cybersecurity hardening of communication networks</td>
<td>5%</td>
<td>5%</td>
<td>41%</td>
<td>41%</td>
</tr>
<tr>
<td>Unknown</td>
<td>3%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>
To achieve a comprehensive, unified cybersecurity and risk management approach for the industry, companies should consider a comprehensive approach

1. Evaluate current state cyber security programs to identify areas of improvement

2. Develop a clear framework for mitigating and managing cyber risks

3. Fortify information technology systems and create a security-minded culture across companies

While no solution is guaranteed to avert all attacks, developing a shared, holistic approach to cybersecurity risk management may give companies a huge advantage.
3 Summary
Summary

• The 2018 global MRO market is at $77.4 BN and is anticipated to reach $115 BN by 2028

• OEMs are expected to continue their push into MRO services and will hit or come close to meeting their growth ambitions

• At the same time, MROs continue to battle higher material and labor costs and there are no clear, easy answers

• Finally, cyber threats are mounting, causing increasing disruption across industries and will impact ours soon; we need to be prepared

This presentation and related reports are available at www.OliverWyman.com/MROSurvey2018