Today’s Agenda

1. Industry Context
2. MRO Market
3. Trends to watch
Industry Context
The global airline industry achieved record profitability of over $35B USD in 2016... driven by low fuel costs and greater cost control...

**GLOBAL AIRLINE PROFITABILITY, 1997 – 2017F**

- **Latin America, $0.2B**
- **Middle East, $0.3B**
- **Asia Pacific, $6.3B**
- **Europe, $5.6B**
- **North America, $18.1B**
- **Africa, ($0.8B)**

Source: IATA, ICF Analysis
...but many airlines continue to struggle though North America has been a bright spot and is leading with way in 2017

GLOBAL AIRLINE EBIT MARGIN BY REGION

Source: IATA/ICF Analysis
INDUSTRY CONTEXT

Commercial aircraft OEM production backlog remains at historical highs…

COMMERCIAL AIRCRAFT OEM PRODUCTION BACKLOG

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Backlog</td>
<td>2,000</td>
<td>3,000</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Backlog/ % Active Fleet</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>70%</td>
</tr>
</tbody>
</table>

Source: CAPA, ICF Analysis

DRIVERS OF OEM BACKLOG

- Emerging market growth
- Very low interest rates
- Previously high oil and commodity prices
- Introduction of new technology aircraft/engines

The MRO Market & Key Trends

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ICF
... and more stable fuel costs have slowed aircraft retirements

### COMMERCIAL AIR TRANSPORT ANNUAL AIRCRAFT RETIREMENTS

<table>
<thead>
<tr>
<th>Year</th>
<th># Retirements</th>
<th>% Installed Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>1993</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>1995</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>1997</td>
<td>203</td>
<td>0.0%</td>
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<tr>
<td>1999</td>
<td>203</td>
<td>0.0%</td>
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<tr>
<td>2001</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2003</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2005</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2007</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2009</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2011</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2013</td>
<td>203</td>
<td>0.0%</td>
</tr>
<tr>
<td>2015</td>
<td>203</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

**INDUSTRY IMPACT**

- **MRO suppliers - positive:** increased spend on older airframes & engines
- **Surplus market suppliers - positive:** reduced part-out “feed stock”
  - OEMs: improved new part sales
  - Distributors: improved used part values / pricing
- **Operators – negative:** increased material costs

Source: CAPA, Airline Monitor, ICF analysis

The MRO Market & Key Trends

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INDUSTRY CONTEXT

Four external macro-economic forces are creating headwinds for global airlines and the broader aerospace & MRO supply chain

OVERVIEW OF EXTERNAL MACRO-ECONOMIC FORCES

Fuel Costs
U.S. Gulf Coast Jet Fuel

Growth of Populism/Nationalism & Impact to Global Trade

INDUSTRY IMPACT

- Increased airline costs:
  - Aircraft financing
  - Fuel
  - MRO
- Downward pressure on global GDP growth
- Downward pressure on aircraft valuations
- Potential for increase in aircraft delivery deferrals (backlog risk)

The MRO Market & Key Trends
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MRO Market
The current commercial air transport fleet consists of ~28,000 aircraft; ~8,300 are located in North America.

**2016 GLOBAL COMMERCIAL AIR TRANSPORT FLEET**

**BY AIRCRAFT TYPE**
- Narrowbody Jet: 54%
- Regional Jet: 13%
- Turboprop: 14%
- Widebody Jet: 19%

**~28,000 Aircraft**

**BY GLOBAL REGION**
- North America (~8,300): 30%
- Europe: 28%
- Asia Pacific: 25%
- Latin America: 7%
- Middle East: 5%
- Africa: 5%
- South America: 7%

Source: ICF Analysis: CAPA 2016
The current commercial air transport fleet consists of under 58,500 engines; narrowbody engine types continue to dominate.

2016 GLOBAL COMMERCIAL AIR TRANSPORT ENGINE FLEET

**By Aircraft Type**
- Regional Jet: 13%
- Narrowbody Jet: 52%
- Widebody Jet: 22%
- Turboprop: 13%

**By Engine OEM**
- Pratt & Whitney: 37%
- CFM International: 37%
- Rolls-Royce: 11%
- IAE: 10%
- GE: 21%
- Others: 7%
The combination of strong air travel demand and the need to replace ageing aircraft will drive fleet growth at a healthy 3.2% p.a.

10 YEAR GLOBAL AIR TRANSPORT FLEET GROWTH

<table>
<thead>
<tr>
<th>Region</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>4.1%</td>
</tr>
<tr>
<td>Middle East</td>
<td>5.0%</td>
</tr>
<tr>
<td>Latin America</td>
<td>3.4%</td>
</tr>
<tr>
<td>Europe</td>
<td>2.4%</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>4.8%</td>
</tr>
<tr>
<td>North America</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Total: 3.2%

Source: ICF Analysis: CAPA 2016
2016 commercial air transport MRO demand is $67.6B; Asia is now larger than North America and Europe in market size

2016 COMMERCIAL AIR TRANSPORT GLOBAL MRO DEMAND

BY MRO SEGMENT

- Components: 22%
- Airframe: 17%
- Engines: 40%
- Modifications: 8%

BY GLOBAL REGION

- Europe: 26%
- Asia Pacific: 30%
- North America: 27%
- Middle East: 8%
- South America: 5%
- Africa: 4%

Source: ICF Analysis: CAPA 2016
The global MRO market is expected to grow by 4.1% per annum to over $100B by 2026

10 YEAR GLOBAL COMMERCIAL AIR TRANSPORT MRO DEMAND (CONSTANT 2016 US$)

Category, CAGR
- Modifications, 5.2%
- Airframe, 2.8%
- Line, 3.2%
- Component, 4.2%
- Engine, 4.5%

Total: 4.1%

Source: ICF Analysis: CAPA 2016
MRO MARKET

Narrowbody 737 and A320 Family engines continue to lead engine MRO spending

2016 COMMERCIAL AIR TRANSPORT GLOBAL MRO DEMAND (CONSTANT 2016 US$)

BY ENGINE OEM

$26.9B

- GE: 27%
- Rolls-Royce: 19%
- Pratt & Whitney: 10%
- CFM International: 29%
- Pratt & Whitney Canada: 11%
- Others: 3%

BY ENGINE MODEL

$26.9B

- CFM56-7B: 15%
- V2500-A5: 10%
- GE90-115B: 9%
- CFM56-5B: 9%
- Trent 700: 9%
- PW4000-94: 7%
- CF6-80C2: 4%
- Trent 800: 2%
- Others: 35%

Source: ICF Analysis: CAPA 2016

The MRO Market & Key Trends
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North American MRO spend exhibits marginal growth, increasing by 1.8% per annum to ~$21.4B by 2026

10 YEAR NORTH AMERICAN COMMERCIAL AIR TRANSPORT MRO DEMAND (CONSTANT 2016 US$)

Category, CAGR

- Modifications, 2.4%
- Airframe, 0.4%
- Line, 2.0%
- Component, 2.7%
- Engine, 1.6%

Total: 1.8%

Source: ICF Analysis: CAPA 2016
North American MRO spend exhibits marginal growth, increasing by 1.8% per annum to $21.4B by 2026

10 YEAR NORTH AMERICAN COMMERCIAL AIR TRANSPORT MRO DEMAND (CONSTANT 2016 US$)

Source: ICF Analysis: CAPA 2016
ICF OBSERVATIONS

- Today, ~60% of the aircraft heavy airframe MRO spend is generated by aircraft that are based on 1960s-1980s technology such as the MD-80, 757 & 747.
- By 2026, ~30% of the MRO spend will be coming from new technology aircraft such as the A350 & 787.

**NORTH AMERICAN HEAVY AIRFRAME MRO SPEND BY AIRFRAME MATURITY (CONSTANT 2016 US$)**

<table>
<thead>
<tr>
<th>$ USD (billions)</th>
<th>2016</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3</td>
<td>$2.8B</td>
<td>$2.9B</td>
</tr>
<tr>
<td>$2</td>
<td>58%</td>
<td>43%</td>
</tr>
<tr>
<td>$1</td>
<td>42%</td>
<td>29%</td>
</tr>
<tr>
<td>$0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **CAGR**
  - Old: -6.6%
  - Mature: 0.6%
  - New: 58.1%
  - Total: 0.52%

Note: 2016 constant $  
Source: ICF
Trends To Watch
RONA-Driven Airlines
Airlines are achieving high return on invested capital (ROIC) levels

ROIC AND FUEL COSTS (2004 – 2017F)

Jet Fuel Price and Airline ROIC over time from 2004 to 2017F.

Source: IATA, ICF Analysis
Capacity management and asset utilization are replacing market share as key metrics…

The airlines have historically been run by operationally-minded people, who tended to throw planes onto routes in a fight for market share. The name of the game is now capacity management, and the decision makers are the finance people. Derek Kerr, CFO, American Airlines

Source: ICF Research / IATA
For example, Delta is focused on managing costs and maintaining capacity discipline.

RONA-driven airlines intently focus on costs:

- Deferring maintenance
- Managing inventory
- Utilizing Used Serviceable Material
- Make vs buy
- Negotiating hard with suppliers

Source: Delta Air Lines / J.P Morgan Aviation, Transportation and Industrials Conference, March 15, 2017
Whole Lifecycle MRO Solutions
With new aircraft orders softening, OEMs are even more focused on the aftermarket

**Nov 2016:**
- Announces goal to triple services revenue to $50B USD over the next decade
- Hires ex-chief of GE’s services business to lead Boeing’s commercial unit

**Dec 2016:**
- Announces the establishment of a dedicated support division
- Announces goal to increase services revenue from 15% to 25% over next 10 years

**Dec 2016**
- 50% aftermarket revenue growth objective by 2020
- Opened a new support facility in London and looking to further expand existing U.S. & China support facilities

Source: ICF, Reuters, Bloomberg
Aftermarket strategies vary across the aircraft lifecycle

Revenue/ profit

Aircraft OEMs

Component OEMs

MRO Integrators

Independent MROs

Engine OEMs

Integrators

- How best to secure capability on new platforms?
- Airframe OEMs – customer, supplier or competitor?
- Who best to partner with?

Airframe OEMs

- Will Airframe OEMs succeed in the MRO market?
- Is their value-add clear?

Component OEMs

- Which integrators to work with – the airlines and/or Airframe OEMs?
- Surplus parts strategy

Engine OEMs

- Focusing on lessors, remarkability and residual values
- Leveraging Big Data
- Emphasizing choice of service offerings and service providers
- Embracing surplus, module swaps, reduced workscopes

Independent MROs

- Which will survive?
- What niches to pursue?
- What partnership strategy?

Source: ICF
Modifications
Improved airline revenues are yielding increased modifications spending particularly in the cabin

10 YEAR GLOBAL AIR TRANSPORT MODIFICATION MRO DEMAND

<table>
<thead>
<tr>
<th>$B</th>
<th>2016</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$2</td>
<td>31%</td>
<td>36%</td>
</tr>
<tr>
<td>$4</td>
<td>28%</td>
<td>23%</td>
</tr>
<tr>
<td>$6</td>
<td></td>
<td>19%</td>
</tr>
<tr>
<td>$8</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>$10</td>
<td></td>
<td>$8.5B</td>
</tr>
</tbody>
</table>

- Africa, 8.5%
- South America, 7.2%
- Middle East, 9.3%
- North America, 2.4%
- Europe, 3.2%
- Asia Pacific, 6.9%

Total: 5.2%

MODIFICATION MARKET OBSERVATIONS

- The interiors market is further consolidating through M&A as well as aircraft OEMs signing exclusive SFE deals with seat suppliers
- M&A examples
  - Rockwell Collins and B/E aerospace acquisition
  - Safran and Zodiac
- Boeing licensed Encore as SFE seat supplier on the 737 in 2016
- Airbus signed an SFE economy seat contract with Recaro in 2015

Source: ICF
Airbus is hoping to capitalize and has set up a dedicated interior services division

**NEW AIRBUS CABIN INTERIOR CONCEPTS: A380 11 ABREAST & AIRBUS FOLDING SEAT SMART CABIN**

**MODIFICATION MARKET TRENDS**

- Recently, Airbus created Airbus Interiors Services (AIS) to perform commercial aircraft cabin upgrade work
- AIS has three lines of business:
  - Tailored equipment
  - Upgrade solutions
  - Innovative products
- Supporting A380 remarketing
- Airbus new 11 abreast configuration on the A380 will be introduced in 2017
- Other cabin innovations include:
  - Airbus's Smart Cabin Configuration concept features folding seats
  - 27 inch pitch slimline seats

Source: ICF International, Airbus
Impact of New Technology Aircraft
The “new technology” fleet is set to grow significantly

AIR TRANSPORT FLEET DEVELOPMENT BY TECHNOLOGY GROUPING

<table>
<thead>
<tr>
<th># Aircraft</th>
<th>2016</th>
<th>2021</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>28k</td>
<td>34k</td>
<td>38k</td>
</tr>
<tr>
<td>Mature</td>
<td>25k</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Old</td>
<td>4k</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>35k</td>
<td>34k</td>
<td>38k</td>
</tr>
</tbody>
</table>

Segment, CAGR
- New, 32.7%
- Mature, -1.9%
- Old, -7.8%
- TOTAL = 3.2%

Old: first flight <1990s, e.g. A300/A310 / 747-1/2/3 / BAe146
Mature: first flight >1990s, e.g. 737CL / 737NG / A330/340 / 777 / E-Jet
New: first flight >2005; e.g. 787 / A350 / A380 / CSeries / E-Jet E2

Source: ICF

OBSERVATIONS

- A fleet of new aircraft was introduced in the 2010s, as the A350 and B787 led a number of new re-engine aircraft types
- As the A320NEO and 737MAX enter service, the new technology fleet is set to grow significantly
- This category will grow at a ~33% CAGR over the next decade, and will represent nearly 50% of the total fleet by 2026, displacing older and mature aircraft
MROs need to understand how best to realize value from the disparate terabytes of data generated by new technology aircraft.

**LEGACY VS NEXT-GEN DATA TRANSFER CAPABILITY**

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>AHM Parameters</th>
<th>Transmittable Data (MB/Flight)</th>
<th>A/C Data Generated (TB/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>767</td>
<td>10,000</td>
<td>~ 28MB</td>
<td>~ 137TB</td>
</tr>
<tr>
<td>A320</td>
<td>15,000</td>
<td>&lt; 1MB</td>
<td>~1,100%</td>
</tr>
<tr>
<td>B787</td>
<td>100,000</td>
<td>767</td>
<td>~11T B</td>
</tr>
</tbody>
</table>

**KEY ISSUES**

- Stakeholder battle: who will control and profit from the operating data IP?
  - Operators
  - Lessors
  - OEMs
  - MRO suppliers
- Ownership and control of data, workscope and assets is key
- Big data analytics is a key enabler

**Big Data Analytics:**

- Aircraft health monitoring
- Predictive maintenance
- Inventory optimization

**Leading to…**

- Improved aircraft availability
- Reduced maintenance costs and improved cost control including optimized inventory
New technology aircraft continue to challenge traditional MRO sourcing strategies

### THE CHALLENGES

- **Getting a return on investment**
  - Facilities
  - Tooling & Equipment
  - Training
  - IT Systems

**Implications for legacy infrastructure and staff as new aircraft enter into service**

### IMPACT OF NEW TECHNOLOGY AIRCRAFT

#### 767 VS 787 HEAVY MAINTENANCE SCHEDULE

<table>
<thead>
<tr>
<th>12 Year Heavy Maintenance Schedule</th>
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<tbody>
<tr>
<td><strong>767</strong></td>
</tr>
<tr>
<td>A/C Age</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
</tr>
<tr>
<td><strong>787</strong></td>
</tr>
</tbody>
</table>

= Light C-Check  = Heavy C-Check

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Volume (C-checks)</th>
<th>Intensity (man-hours)</th>
<th>Days (Hangar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>767</td>
<td>8</td>
<td>95,000</td>
<td>136</td>
</tr>
<tr>
<td>787</td>
<td>4</td>
<td>33,000</td>
<td>47</td>
</tr>
</tbody>
</table>

- **Cost Savings:** ~65% fewer routine airframe heavy maintenance man-hours drives an estimated savings of ~$3.5M
- **Asset Utilization:** ~90 additional available flying days enables increased revenue generation potential

*Based on 4,000 FH/yr utilization
767 C-check = 18mo, 4C = 72mo; 787 C-check = 36mo, 4C = 144mo
Assumed industry standard labor man-hour rate
Aircraft out of Service (AooS) calculated for C/4C/8C checks assuming industry standard MRO hangar productivity

The MRO Market & Key Trends

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Considerations
In Conclusion…

• The Air Transport MRO market outlook remains robust with expected growth of 4.1% per annum to reach ~$100B by 2026

• North American MRO grows slowly at 1.8% from $18B to $21B by 2026

• MRO participants are promoting new value propositions to better meet operator and lessor needs across the lifecycle (and signing new partnerships along the way)

• Growth in New Technology Aircraft brings change that provides opportunities and challenges

• With a highly competitive aftermarket ecosystem, MROs need to continually identify “how to win” and invest to maintain leadership
Thank You!

Richard Brown

richard.brown@icf.com

+44 7718 893 833
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- **Aircraft**
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- **Aerospace & MRO**
  Operations assessment, M&A support, marketing analysis, strategy development

ICF offers our team of nearly 100 aviation experts dedicated to strategic and operations consulting for the aviation industry. Our aviation practice was founded as SH&E in 1963 and expanded with the acquisition of AeroStrategy in 2011. Today we are one of the world’s largest aviation consulting organizations. We provide objective, independent commercial, financial, technical, and regulatory guidance to aviation clients, including airlines, airports, lessors, financial institutions, manufacturers, governments, and VIPs. From our offices around the globe, ICF helps aviation clients manage assets and operations, mitigate risk, and maximize return on investment.

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ICF guides manufacturers, airlines, independent MROs, suppliers, and the financial community through every step of the aerospace and MRO supply chain to realize value and deliver strategies that drive growth. We understand and focus on the key aspects of the industry, and have the proprietary tools necessary for successful operations. Below, we briefly describe our core aerospace & MRO services and proprietary supporting products.

**AEROSPACE AND MRO PRODUCTS**

**ICF’s suite of proprietary aerospace & MRO tools, models, and databases helps stakeholders navigate key business challenges to their advantage.**

<table>
<thead>
<tr>
<th>Strategy Development</th>
<th>Transaction Support</th>
<th>Operations and Supply Chain</th>
<th>MRO Business Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveraging years of aerospace and MRO advisory experience as well as proprietary market intelligence, ICF delivers data-driven, objective insight to underpin sustainable strategies.</td>
<td>For clients’ investment decisions, ICF combines global thought leadership in aerospace and MRO supply chain with accurate market intelligence, operations expertise, and unparalleled industry contacts.</td>
<td>ICF’s proven tools and methodologies offer improved performance and cost reduction across manufacturing, operations, and all phases of make-buy supply chain planning and execution.</td>
<td>For airlines, OEMs, and independent MROs, ICF has deep experience in comprehensive operational and financial diagnostics based on extensive proprietary benchmarks, followed by results-oriented improvement programs.</td>
</tr>
</tbody>
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**Fleet & MRO Forecasts**

Proprietary, independent forecasts for commercial and business aviation, industrial gas turbine, and military markets.

**Value Database**

Production value breakdown by component category and raw material content across the aerospace supply chain.

**MRO Best Practices and Benchmarks**

Comprehensive, proprietary databases on processes, costs, and organization.