Aeronautical Repair Station Association

2014 Global Air Transport:

Fleet size	23,010
2014-24 fleet growth rate	3.6%
MRO market	$57.7B
2014-24 MRO growth rate	4.2%

2014 Global Civil MRO:

Firms	4,700+
Small/medium enterprises (SME)	78%
Maintenance employees	473k

2014 U.S. Civil MRO:

Firms	4,000+
Small/medium enterprises (SME)	84%
Maintenance employees	244k

2014 U.S. Economic Activity*:

Total	$44.4B
MRO	$21.3B
Parts Manufacturing/Distribution	$23.1B

* includes business aviation

Global MRO Market Economic Assessment

Air Transport

PREPARED BY:

TEAM SAI CONSULTING SERVICES

www.teamsai.com

404.762.7257

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EXECUTIVE SUMMARY

This report details TeamSAI's assessment and ten-year outlook of the air transport maintenance, repair, and overhaul (MRO) market starting with a review of global economic conditions, a key driver in the health of the industry. The global economy is expected to improve in the coming years, but concerns remain over the pace and complexion of this recovery. While no two airlines are the same, generally speaking, across the world and especially in North America, airlines operate with very thin margins. Thus, major cost drivers, such as labor, maintenance, and fuel, greatly influence their performance. Operators are relentless in their pursuit of managing these costs. With limited leverage over labor and fuel costs though, airlines are right to focus attention on the cost of maintenance.

The global air transport fleet in scheduled, commercial service and powered by jet and turboprop engines consists of more than 23,000 aircraft. Nearly one-third of this fleet is domiciled in North America. Twenty percent of the fleet is in Western Europe; Eastern Europe adds another 5%. Asia Pacific, including China and India, has more than a quarter of the world's fleet. But the fleet composition is changing. North America, which is undergoing significant re-fleeting, is expected to see its share decline, as its net growth is very limited in the ten-year horizon. Asia Pacific and other emerging regions are expected to see a greater share of the total fleet, and therefore, represent the MRO growth engines for the industry.

Globally, the air transport MRO market in 2014 is expected to be $57.7B and grow to $86.8B by 2024 (for jets and turboprops combined). This represents a healthy 4.2% compound annual growth rate (CAGR). The market segments of airframe, engine, component, and line MRO each have a different growth profile in the outlook:

Airframe MRO is forecast at $11.5B for 2014. Nearly 30% of this spend is for aircraft based in North America. Airlines themselves and their affiliated third-party providers maintain a solid hold on this market based on publicly-announced contracts. The airframe MRO market typically is considered a low-margin, labor intensive segment.

Engine MRO is expected to be $22.1B in 2014. More than 30% of this value is tied to North American operators. Unlike airframe MRO, engine MRO is largely contracted out and engine original equipment manufacturers (OEMs) have a large share of this market. Engine MROs, recognizing the value of the aftermarket, typically enjoy higher margin work which is also more material intensive.

Component MRO is forecast to be $12.2B in 2014. Upwards of 35% of this spend is for North American aircraft. Like the engine MRO business, much of the component MRO market is contracted out, though it varies greatly from one component type to the next. Similarly, the labor/material mix can vary.

Line MRO is pegged at $11.9B in 2014. North America represents 27% of the market. The nature of line maintenance makes it less prone to contracting; however, the potential to tap this market represents a significant opportunity in an otherwise slowly growing market. Of course, these opportunities may be limited to far flung airports. Because the work is labor-intensive, the opportunities to take advantage of economies of scale are constrained.

The commentary continues with an examination of the flow of work between regions which reveals that North America is a net importer of airframe maintenance but is a net exporter of engine MRO. Structural characteristics in the economy have led to these trends. However, as labor rate differentials between developed and developing regions narrow, North America will be ripe to reverse its status as a net importer of airframe maintenance. Similarly, engine and component OEMs—most common to North America and Western Europe—have relied heavily on their intellectual property to capture a greater share of their respective aftermarkets. OEMs will continue to gain ground as significant MRO providers in these areas during the forecast period.

In terms of economic activity, MRO plays a significant role. In the United States, nearly 4,100 firms with over 244,000 employees operate in the civil MRO market (including airline employees). Small and medium-sized enterprises (SME) account for 84% of these U.S. firms and 21% of all employees. There are over 143,000 technicians in the U.S. and approximately 37% are certificated.

TABLE OF CONTENTS

This commentary details the economic impact of the maintenance, repair, and overhaul (MRO) market. First, macroeconomic conditions are considered. The fleet and related MRO market is then sized for the air transport sector. The market players are then assessed for each segment and across different world regions. Finally, the employment and economic activity within the U.S. civil aviation maintenance market is assessed.

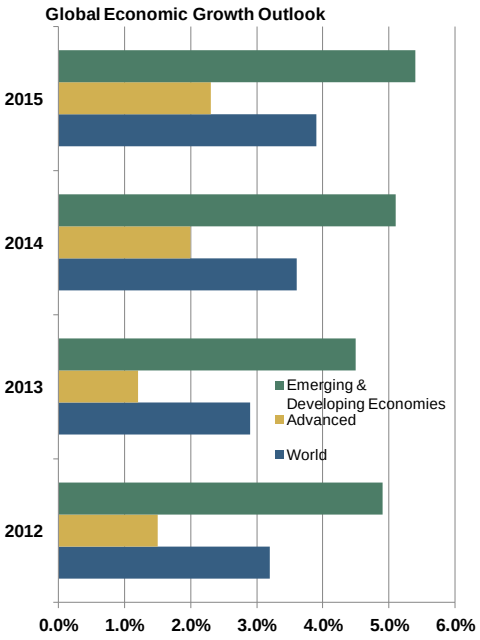
STATE OF THE WORLD

More than five years after the onset of the global financial crisis, the global economy continues to experience modest growth. Economic predictions for 2014 are generally upbeat and anticipate accelerating economic growth. Developing economies will remain the main driver of global growth, but their output will remain below the elevated levels seen in recent years. Developed markets are expected to rebound led by the United States and euro area. As a result, the spread between the growth rates of developed and developing economies is expected to narrow.

Global economic outlook is positive but cautious due to potential downside risks.

GROSS DOMESTIC PRODUCT (GDP)

World gross domestic product (GDP) is expected to grow by 3.6% in 2014 according to the October 2013 International Monetary Fund (IMF) World Economic Outlook update as the factors underlying global activity continue to improve.[1] (See Figure 1.) However, significant risks remain including spillover effects of central bank policies, particularly the U.S. Federal Reserve's tapering of its quantitative easing measures.



Source: IMF World Economic Outlook - October 2013

Figure 1

Developed economies as a whole are expected to see a 2.0% increase in GDP for 2014 (a significant rebound over the expected 1.2% growth in 2013).[2] Drivers of the predicted acceleration in growth are a stronger U.S. economy, a reduction in fiscal tightening, and accommodative monetary conditions.

The U.S. is forecast to experience 2.6% GDP growth in 2014 driven by increased consumer spending, a stronger housing market, and a more positive outlook on unemployment.[3] The euro area, moving slowly out of recession, is expected to grow by 1.0% in 2014.[4] The euro area crisis seems to have passed, but considerable financial, economic, and political challenges remain. Policymakers face significant challenges in restoring confidence in the financial sector caused by large quantities of private and public debt and addressing high levels of unemployment risks that create political instability risk. Growth in the Japanese economy is expected to slow from 2.0% in 2013 to 1.2% in 2014 due to tightening of fiscal policy.[5]

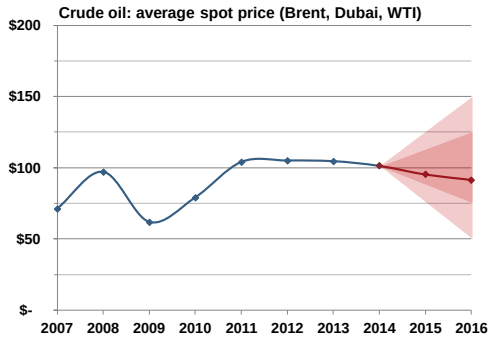
Emerging and developing economies, including China, are expected to grow at 5.1% in 2014.[6] Exports driven by stronger growth in advanced economies and increased consumption encouraged by low levels of unemployment are expected to support this growth. However, growth is not expected to rebound to the high rates experienced in 2010 and 2011. There has been much discussion by economists on the slowdown of growth in emerging economies, particularly whether the slowdown is cyclical or structural in nature.[7,8] The IMF argues that a majority of the slowdown has been caused by the unwinding of previous positive cyclical factors (sharp rebound in exports and high commodity prices), but the overall growth potential of these economies has, to a lesser extent, deteriorated as well. The IMF views China and Russia as two economies affected more by structural factors and expects them to have persistently lower growth rates in the future relative to the previous decade (although Chinese growth is expected to remain in the range of 7-8%). Growth rates of the remaining BRICS countries are expected to remain in line with their averages over the past 15 years in the medium term.

Emerging and developing economies are forecast to have the highest growth rates, though they may not reach the levels seen in recent years as growth moderates and capital investment returns to developed economies.

Global trade remained weak in 2013. According to the World Trade Organization (WTO), world trade will grow by 2.5% in 2013. In 2014, world trade is expected to grow by 4.5%, with exports increasing by 2.8% in developed economies and 6.3% in developing economies. Imports are expected to rise by 2.3% in developed countries and 6.2% in developing countries.[9]

CRUDE OIL

There is a general consensus among noted forecasters that the price of oil will be slightly lower in 2014 compared to 2013. The World Bank forecasts oil to average $101.00/bbl in 2014. The IMF forecasts oil to average $101.40/bbl in 2014 ($3.10/bbl lower than 2013). The International Air Transport Association (IATA) predicts that the price of Brent crude oil will be $104.50/bbl in 2013 (down from $108.20/bbl in 2012). IATA also predicts the price of jet kerosene will be $120.60/bbl in 2014 (3% lower than the $124.00/bbl 2013 price). (See Figure 2.)



Source: IMF, World Bank, TeamSAI Consulting Services analysis

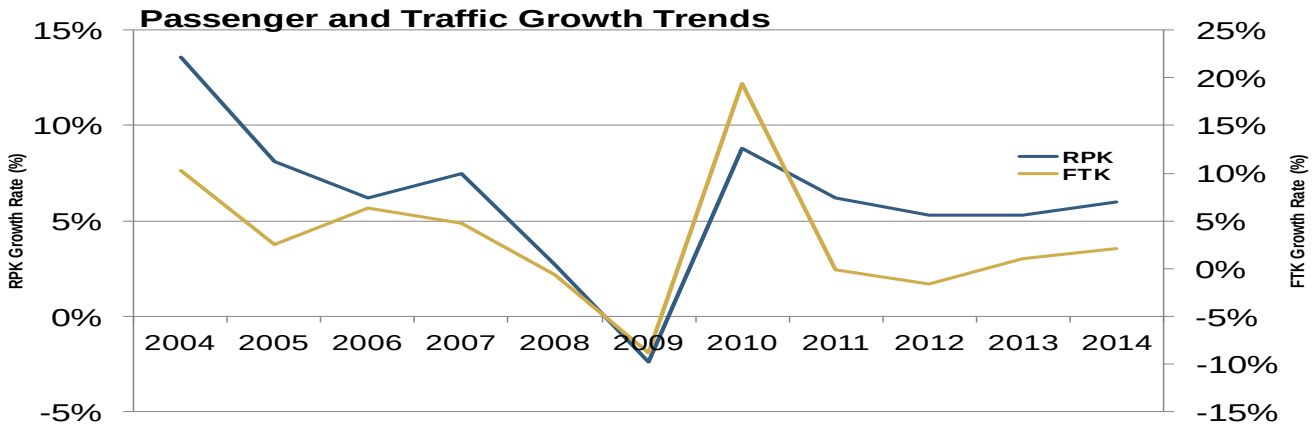
Figure 2

While there are signs that growth is picking up in both developed and developing countries, the world continues to face a fragile recovery. All these economic issues can have significant impact on the airline and MRO industries making their business environments increasingly challenging if conditions worsen.

STATE OF THE AIRLINE INDUSTRY (2013 AND LOOKING FORWARD)

In 2013, air travel is expected to grow by 5.3% (slightly higher than the 20-year average of 5%). Passenger traffic is estimated to top three billion travelers in 2013, an industry first. This growth in traffic, alongside continued capacity discipline by airlines, kept passenger load factors high at 79.9% in 2013. Air freight markets are expected to grow by 1.0% in 2013 after contracting by 1.6% in 2012.

PASSENGER AND TRAFFIC OVER THE LAST DECADE



Source: IATA

Figure 3

According to IATA's December 2013 Financial Forecast, increasing levels of passenger traffic, lower fuel costs, and technological efficiencies have generated better than expected financial performance in 2013. IATA believes that industry consolidation and partnerships are leading to high profitability, which is expected to continue over the next few years. IATA raised its forecast for airline profits in 2013 from $11.7B to $12.9B. (See Figure 4.) Expected performance in 2013 is considerably better than the $7.4B net profit of 2012.

"Airlines are demonstrating that they can be profitable in adverse business conditions with efficiencies being generated through myriad actions: consolidation, joint ventures, operational improvements, new market development, product innovations and much more," states IATA CEO Tony Tyler.[10]

The upward trend should continue into 2014 when airlines are expected to return a net profit of $19.7B. This would make 2014 the strongest year ever in terms of net profit—topping the $19.2B in 2010. The 2014 IATA forecast is driven by slightly higher economic growth in 2013, increased revenue from ancillary services, improvements to industry structure and efficiency, and slightly lower fuel prices. Fuel costs are expected to decrease slightly in 2014 as a percentage of airline operating costs to 30%.

North American airlines continue to improve their profitability as seen in IATA's most recent forecast ($5.8B in 2013 and $8.3B in 2014). Net profits in Asia Pacific are forecast to be $3.2B in 2013 and $4.1B in 2014. European airlines are expected to recover in 2013 and 2014 (net profits of $1.7B in 2013 and $3.2B in 2014).

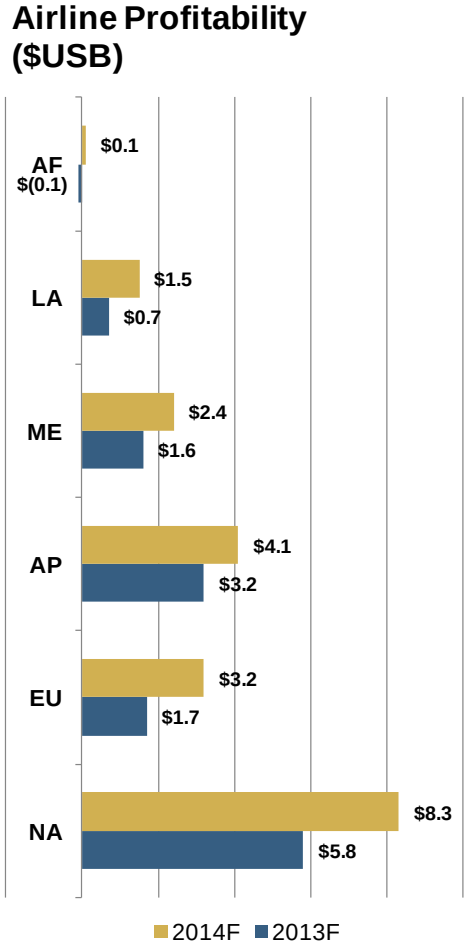
Overall, traffic is expected to grow by 6.0% in 2014. North American passenger traffic (RPK) is expected to grow at 2.5% in 2014. European traffic is forecast to increase by 4.7%, and traffic in Asia Pacific is predicted to grow by 7.4%. The Middle East, Latin America, and Africa are forecast to experience the highest traffic growth rates in 2014 (13.0%, 8.5%, and 7.8%, respectively). For the air freight market, IATA predicts freight ton kilometer (FTK) growth of 2.1% in 2014.[11]

Overall, the outlook for 2014 is largely positive as profitability is forecasted to continue to improve. However, the airline industry remains a low-margin business, and the balance between profit and loss remains delicate. Net margins are expected to remain weak at 2.6% in 2014.[12] With this thin margin, the industry remains highly susceptible to negative shocks.

"Airlines are demonstrating that they can be profitable in adverse business conditions with efficiencies being generated through myriad actions: consolidation, joint ventures, operational improvements, new market development, product innovations and much more."

- Tony Tyler, IATA CEO

AIRLINE PROFITABILITY (US$B)



Note:
AF... Africa
LA... Latin America & the Caribbean
ME.. Middle East
AP .. Asia Pacific
EU .. Europe
NA .. North America

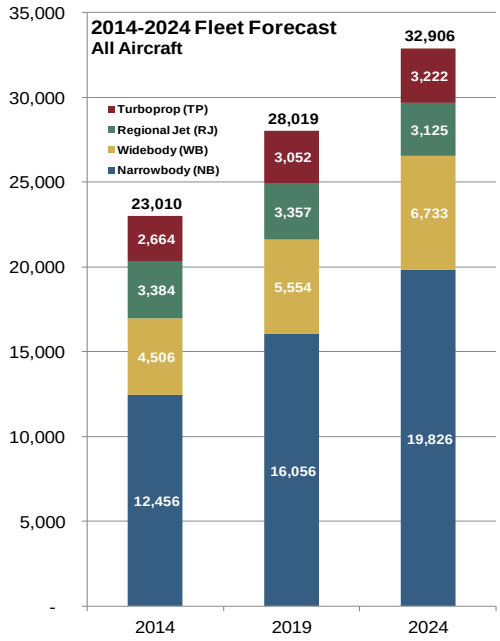
Source: IATA, December 2013

Figure 4

GLOBAL AIR TRANSPORT FLEET FORECAST

The global turbine-powered air transport fleet is about 23,000 aircraft. (See Figure 5.) Nearly one-third of this fleet is domiciled in North America. Twenty percent of the fleet is in Western Europe; Eastern Europe adds another five percent. Asia Pacific, China, and India combined have more than a quarter of the world's fleet. But the fleet composition is changing. North America, which is undergoing significant re-fleeting, is expected to see its share decline, as its net growth is very limited. Emerging markets are expected to see a greater share of the market, and therefore represent areas of MRO growth.

FLEET FORECAST (2014-24)



Source: TeamSAI Consulting Services analysis

Figure 5

GLOBAL AIR TRANSPORT MRO MARKET FORECAST

Definitions

MRO is comprised of four main segments of maintenance: (1) airframe; (2) engine; (3) component; and (4) line.

Airframe Maintenance

Airframe maintenance involves work carried out on a regular, scheduled basis to inspect, maintain, repair, and conduct preventive maintenance for the airframe's structure and cabin interior. As a consequence, the aircraft is removed from commercial service for a generally predetermined period of time at specified intervals. Individual airlines are responsible for conducting this maintenance (either by themselves or through a qualified provider) in compliance with the applicable aviation safety regulations (e.g., the Federal Aviation Administration (FAA), the European Aviation Safety Administration (EASA), etc.). As such, these individual airlines develop schedules for airframe maintenance to meet safety and operational requirements.

Airframe maintenance consists of light C checks and heavy checks (e.g., 4C and larger).

Such scheduled work scopes are typically based on calendar time, a fixed number of flight hours, or a fixed number of flight cycles. While some operators and aircraft types have highly-customized maintenance programs such as "phase checks" and "overnight C checks," the vast majority fit into a traditional model of a light C check and a heavy maintenance visit (HMV). Each aircraft model is different, but for illustrative purposes, an average light C check occurs typically every 18-24 months while the HMV (often also called a "D check," "4C Check," or "Structural C Check") usually occurs every 60-84 months. However, the C check interval can range from 12 to 36 months. HMV checks can range from 60 to 144 months. Newer generation aircraft often have longer intervals; turboprops and older aircraft have the shortest intervals. (See Table 1.)

Activity	Description	Frequency	Man-hours required
C Check	Detailed inspection	12-36 months 2000-12000 FH 1000-15000 FC	1000-15000Mhrs 3800 wtd avg
HMV (or D Check or 4C Check)	Major reconditioning	48-144 months 8000-36000 FH 6000-24000 FC	2000-70000Mhrs 11600 wtd avg

Note: all intervals are highly dependent on the flight profile of the actual aircraft

Table 1

Engine Maintenance

Engine maintenance is limited to off-wing work only for the purpose of this study.

Engine maintenance involves work carried out on a scheduled or on-condition basis to inspect, maintain, repair, and conduct preventive maintenance for the purpose of returning the engine to service or restoring performance margins. Engine maintenance under consideration is limited to off-wing work that requires significant effort to disassemble, repair, restore, and return to service each engine that powers the aircraft. Engine maintenance is often divided into shop visit overhaul work and replacement of life-limited parts (LLP). As a consequence, the engine is removed from commercial service for a period of time. While individual air transport airline operators exercise a degree of autonomy over when the engine overhaul occurs, LLP events must adhere to more rigid intervals. However, for modeling purposes, all events are estimated at an average flight hour or flight cycle interval. (See Table 2.)

Activity	Description	Frequency	Shop Visit Overhaul Cost	Life-Limited Parts (LLP)	Total Cost
Overhaul	Off-wing disassembly, inspection, repair/ replacement of parts (including LLP), re-assembly, test	3000-24000 FH 1500-15000 FC	$200k - $6.5M $2.3M wtd avg	$0 - $2.1M $900k wtd avg	$200k - $8.6M $3.2M wtd avg

Note: all intervals are highly dependent on the flight profile and specific LLP limits of the actual engine

Table 2

Component Maintenance

Component maintenance involves work carried out in the shop environment when components have been removed from an aircraft due to condition or schedule to inspect, maintain, repair, and conduct preventive maintenance in order to return them to serviceable condition. This represents the average aggregate component maintenance expense for off-wing repair and overhaul of components. As a consequence, the component is removed from commercial service for a period of time after being removed from an aircraft as unserviceable. Individual airlines are responsible for conducting this maintenance (either by themselves or through a qualified provider) in compliance with the applicable aviation safety regulations. As such, these individual airlines develop policies and procedures for handling component maintenance to meet safety and operational requirements; with increasing frequency, airlines are contracting this work on a cost per flight hour or cycle basis.

Component maintenance covers a wide range of work across many ATA chapters.

While no one system dictates how the component maintenance market should be organized, for modeling purposes, the component MRO market is grouped as follows. (See Table 3.)

Component sub-segment	Description
Avionics	Maintenance related to auto flight, communications, indicating/recording systems, navigation, and integrated modular avionics
Auxiliary Power Unit (APU)	Maintenance of the auxiliary power unit
Cabin Systems	Maintenance of cabin core systems, inflight entertainment system (such as audio, video, and WIFI equipment), external communication system, cabin mass memory system, cabin monitoring system, miscellaneous cabin system
Equipment/Furnishings	Maintenance of the aircraft equipment and/or furnishings, such as buffets/galleys, lavatories, cargo compartments, emergency equipment, accessory compartments, and insulation
Electrical	Maintenance of the generator drive, AC generation, DC generation, external power, etc.
Engine Accessories	Maintenance of the ignition, engine air, engine controls, engine indicating systems, engine exhaust systems (excluding thrust reversers), engine oil systems, and engine starting systems
Propellers	Maintenance of the propeller assembly, controlling, braking, indicating, and propeller duct
Flight Controls	Maintenance of the flight controls, such as aileron, rudder, elevator, stabilizer, flaps, spoiler, etc.
Structures	Maintenance of the doors, fuselage, stabilizers, windows, and wings
Fuel Systems	Maintenance of the fuel, inflight fuel dispensing, and engine fuel and control systems
Hydraulics	Maintenance of the hydraulic power systems

Component sub-segment	Description
Pneumatics	Maintenance of the pneumatic systems, such as packs, air cycle machines, distribution and indicating
Landing Gear	Maintenance of the landing gear systems, including main gear and doors, nose gear and doors, extension and retraction, etc.
Wheels & Brakes	Maintenance of the wheels and brakes
Tires	Maintenance of the tires
Nacelles/Thrust Reversers	Maintenance of the nacelles/pylons and thrust reversers
Waste & Water	Maintenance of the waste and water systems and the water ballast systems
Cargo	Maintenance of the cargo and accessory compartments, including loading systems and insulation
Other	Maintenance of the air conditioning/environmental control systems, fire protection systems, ice and rain protection systems, lights (flight compartment, passenger compartment, cargo compartment, exterior, and emergency), oxygen systems, vacuum systems, multisystem, diagnostic and maintenance systems, information systems, and inert gas systems.

Table 3

Line Maintenance

Line maintenance involves work carried out on a regular, scheduled basis or in response to discrepancies noted by the flight crews to ensure the aircraft is in an acceptable airworthy condition for operation. This work is conducted before/between operations. As a consequence, the aircraft is not removed from commercial service; however, individual airlines typically budget time (labor) and resources (material and consumables) to conduct this work. This budget includes time and resources for routine and non-routine tasks. Line maintenance scheduled work can be grouped into categories including pre-flight checks, transit checks, daily checks, weekly/overnight checks, and A-checks. (See Table 4).

Line maintenance includes pre-flight checks, transit checks, daily checks, weekly/overnight checks, and A-checks.

Activity	Description	Frequency	Labor input	Material Costs
Pre-flight/Transit checks	Walk-around visual inspections performed by flight crew or mechanic to fix any defects that developed during flight operations	Daily/before each flight	0.5 - 7 Mhrs (depending on a/c and personnel involved)	$0 - $500 per event
Daily checks	Visual inspections and minor routine maintenance, including: • measuring brake pads thickness • inspecting & testing emergency systems and equipment • testing hydraulics • checking fluid levels • reviewing on-board maintenance computer messages • maintaining IFE	Daily (every other day as applicable)	1.5 - 25 Mhrs (depending on a/c and personnel involved)	$30 - $500 per event
Weekly/overnight checks	Similar routine content as the daily checks but allows for additional tasks	Weekly (every other week as applicable)	0 - 30 Mhrs (depending on a/c and personnel involved)	$0 - $1,000 per event
A-checks	Routine and non-routine work included in the weekly check plus: • functionality testing • emergency & safety equipment checks • control surface & mechanisms checks • non-destructive testing	110 - 800 FH	64 - 760 Mhrs (depending on a/c)	$500 - $40k+ per event

Note: all intervals are highly dependent on the flight profile of the actual aircraft

Table 4

MRO Market Size and Forecast

The following sections detail the total air transport MRO market forecast for 2014, 2019, and 2024. (See Figure 6.)

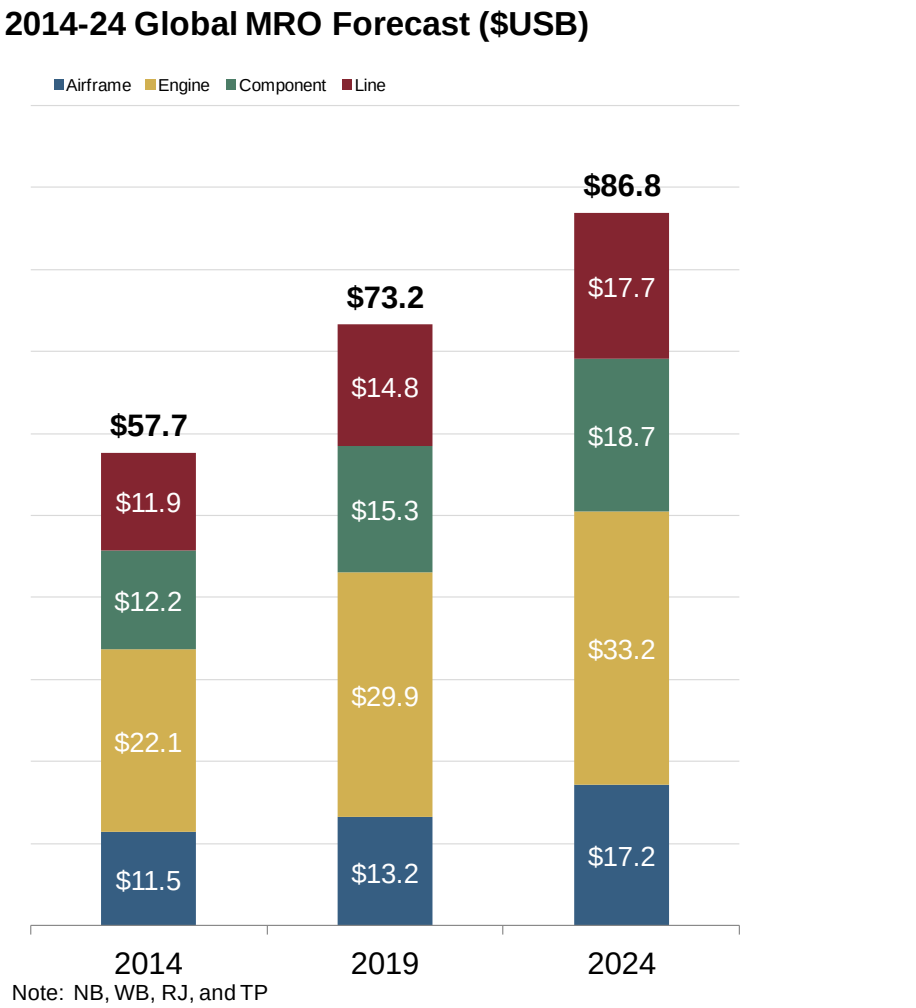
Total MRO in the air transport space for all aircraft classes is forecast to grow from $57.7B to $86.8B or 4.2% annually over the next ten years.

Total MRO – Jets & Turboprops

The fleet forecast as previously discussed drives demand for MRO work. The global air transport MRO (for jets and turboprops) is expected to be $57.7B in 2014. This will rise to $73.2B in 2019, representing a solid growth at 4.9% CAGR. The growth rate will decline to 3.5% in the second half of the forecast period (2019-24). Over the full forecast period, this indicates growth of 4.2%, rising to $86.8B by 2024.

Little change in the relative mix of airframe, engine, component, and line MRO spend is expected over the forecast period.

MRO FORECAST (2014-24)



Source: TeamSAI Consulting Services analysis

Figure 6

Total MRO by Class

On the whole, very little change is expected in the total MRO market mix by aircraft class (NB, WB, RJ, or TP) over the period. (See Figure 7.) Narrowbodies will hold a commanding overall share (upwards of 46-48%) to the widebodies' 40-43%, the regional jets' declining 9%, and the turboprops' 5%. Also, the relative constant mix is true across all market segments.

REGIONS OF THE WORLD

Region	Abbreviation
Africa	AF
Asia Pacific	AP
China	CH
Eastern Europe	EE
India	IN
Latin America & the Caribbean	LA&C
Middle East	ME
North America	NA
Western Europe	WE

Source: TeamSAI Consulting Services analysis

Table 5

Globally, MRO related to narrowbody aircraft dominates the budget. The MRO share mirrors that of the fleet itself—that is, the narrowbody fleet constitutes just over 50% of the total fleet, and the narrowbody MRO constitutes just under 50% of the global MRO. Narrowbody MRO share should continue to grow over the forecast period. Widebody MRO, on the other hand, represents 40-43% of the market over the forecast period, because each aircraft is much more maintenance intensive. (Said differently, the widebody fleet represents just 20% of the global fleet but drives comparatively larger unit costs.) As the global regional jet fleet size declines, regional jet MRO and its share of the total MRO market are expected to decline. The turboprop fleet is expected to grow moderately (1.9% CAGR 2014-2024), which translates into a total MRO market size that will grow at 3.4% CAGR in the first half of the forecast period, then just 0.3% in the second half, as more maintenance-efficient turboprops assume a larger share of the fleet.

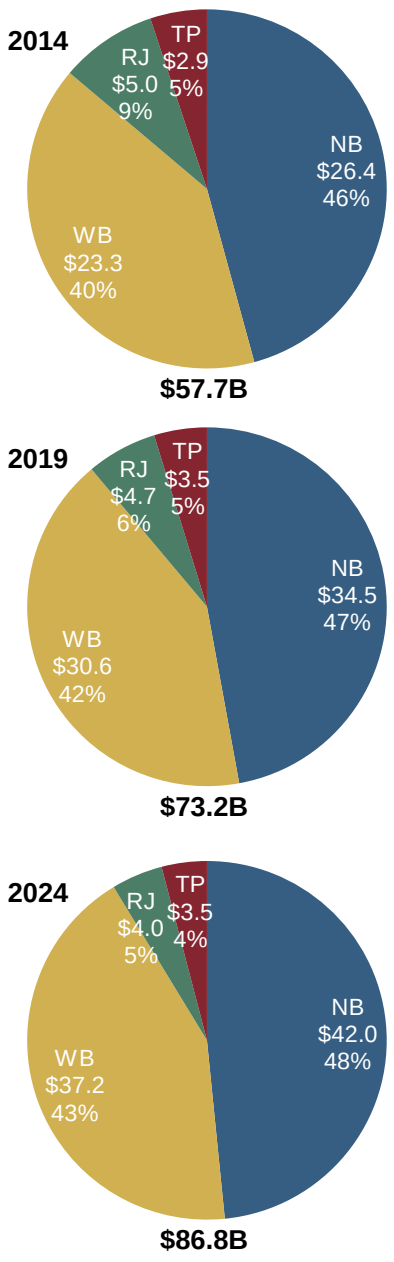
Total MRO by Region

Regionally, as the fleet distribution changes, MRO will follow. North America will remain the largest single region for total MRO value, growing from $17.7B to $19.0B over the forecast period. This represents relatively flat growth at 0.7% CAGR, with very little difference in the first and second half of the forecast period. Latin America and the Caribbean, which represents 5-6% of the total MRO market, is expected to more than double over the period (growing from $2.6B to $5.4B). (See Figure 8.)

Europe is expected to see solid growth. Western Europe should lose some market share, even as it adds $3.4B. Eastern Europe, while relatively small at just 4-5% of the market, is forecast to grow much faster, at 6.2% over the forecast period.

Asia, as has been the case for some years now, remains the growth engine of total MRO. Asia Pacific countries should grow at a healthy 5.0%, rising to the same levels as that of Western Europe and North America. China, which is expected to have an MRO market 2.5 times larger ten years from now, is forecast to grow at 9.8% CAGR. India is expected to grow at well over 10% over the forecast period, but should remain a relatively small share of the total market (1-3%).

MRO FORECAST BY CLASS ($USB)

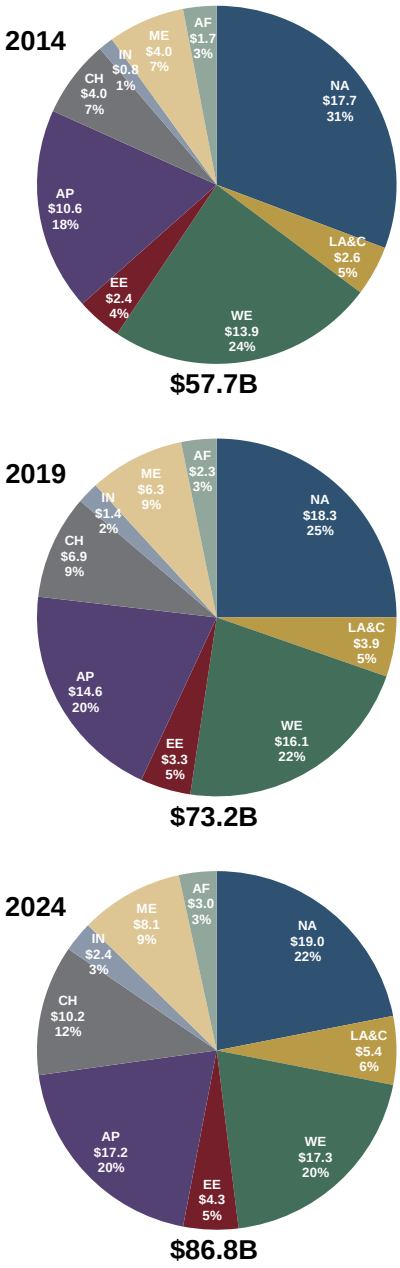


Source: TeamSAI Consulting Services analysis

Figure 7

Narrowbody and widebody MRO are expected to both gain share at the expense of regional jets and turboprops.

MRO FORECAST BY REGION ($USB)



Source: TeamSAI Consulting Services analysis

Figure 8

Together, the Americas, Europe, and Asia represent nearly 90% of the total MRO market. As TeamSAI has pointed out in the past, though, the Americas and Europe are expected to lose market share to Asia. By 2024, Asia (including Asia Pacific, China, and India) is expected to constitute the largest share of the three combined regions.

The Middle East is anticipated to double in market size and constitute nearly 10% of the global MRO market by 2024. Africa too is expected to enjoy healthy growth, but should just maintain its market share.

The highest MRO growth rates are expected in India, China, Eastern Europe, the Middle East, Latin America and the Caribbean, Asia Pacific, and Africa. The lowest rates (i.e., those below the total MRO market CAGR of 4.2%) are again in Western Europe and North America. Growth rates range from a low of 0.7% to a high of 11.8% for the full forecast period (2014-2024).

India's and China's highest MRO growth rates are driven by the growth in the number of aircraft for these regions, which should more than double their respective fleet sizes. Similarly, Eastern Europe, the Middle East, Latin America and the Caribbean, and Asia Pacific also will see their fleets grow to 1.5 times or more their current size by 2024.

Total MRO by OEM

Boeing and Airbus will remain the two dominant players in the air transport aircraft manufacturing market with three-quarters of the fleet or more. Boeing aircraft are expected to maintain the largest share of the global fleet over the forecast period; however, it will lose share as Airbus' share of the fleet approaches that of Boeing. Interestingly though, the share of the MRO market that Boeing aircraft currently drives is notably larger than that of Airbus. Here too though, Airbus's impact is expected to grow to nearly match that of its main rival as its market value doubles in size. Combined, today these two OEMs' aircraft drive 86% of the MRO and by 2024, they are expected to grow this share to 90%.

Bombardier and Embraer aircraft are both expected to lose MRO market share over the forecast period. Some of this loss will be to new entrants to the regional jet market space, while the rest is to operators favoring narrowbodies. This is true despite the fact that Bombardier's narrowbody CSeries will be introduced in the forecast period. The MRO value the CSeries should drive is limited compared to the MRO value Bombardier regional jets will shed as they are phased out of service (especially its CRJ fleet).

Within the regional jet space, Embraer aircraft are anticipated to rise to the top ranking for global MRO, even as its fleets' MRO value climbs at just 0.9% CAGR through 2024. Bombardier's regional jet share could fall more than 50% as its existing aircraft's market potential declines over the forecast period and the OEM turns its focus to the CSeries narrowbody aircraft. Despite the positive press for new regional jets, none of the new entrants in this MRO market space will come close to rivaling either Bombardier or Embraer over the forecast period.

Total MRO by Family and Type Variant

Globally, the ten largest fleets in terms of 2014 MRO value are expected to be (in order) as listed in Table 6 in the left-hand column. Looking ten years forward, the top ten fleets in terms of MRO value are expected to be (in order) as listed in the right-hand column of the same table. Airbus A320 family (including the NEO) and the Boeing 737 NG family (including MAX version in later years) will dominate MRO demand throughout the forecast period. The A320 family has a larger share, but Boeing's 737 family should close that gap by 2024. Both will approximately double in market size by 2024.

The 2014 MRO spend of the A320s and 737 NGs is much more comparable to that of the next three fleet types (777s, 747-400s, and A330s) than it is expected to be in 2024, when the two largest fleets are expected to far outpace the MRO of the next largest fleet. In fact, by 2024, the A320 and 737 families are forecast to constitute a greater share of the MRO market than the next eight fleet types in the top ten. Both will also each be more than double the size of the third largest fleet (777).

The A340 is the one other fleet that will remain in the 2024 top ten. New entrants to the 2024 top ten include the A350, A330, 787, A380, and Embraer 170/175/190/195 & E2 family.

The top thirteen aircraft families in 2014 should exceed $1B. By 2024, the top fourteen aircraft families are forecast to exceed $1B in market value. The next five type variants/families are expected to exceed $500M, which makes for a shorter list than in 2014 when the next eight type variants/families are expected to exceed that threshold.

While the global fleet's MRO will grow 4.2% in ten years, the change in the mix by type variants shows some interesting developments. The entrance of the NEO and the MAX will push these respective families' growth rates to 6.2% and 8.3%, respectively, over the period. Six of the top ten fleets in 2014 are forecast to decline in total MRO value by 2024. These declining fleets will give way to other aircraft types.

The fastest growing fleets in terms of MRO value over the forecast period are the A350, 787, A380, 747-8, and the CSeries. As the fleets of DC-8/9, L-1011, 737-200, DC-10, AvroRJ, and 747-100/200/300 retire, demand for related MRO will dissolve. These fleets currently represent just a small share (about 1%) of the global market though, so their retirement will have little impact on the overall market. More significantly, the 767 and 757, with their combined 10% of the global MRO market in 2014 are expected to fall to less than half that by 2024 and shed 6% of their market share. While this will leave just over $3B in combined market value, they will only fall from sixth and seventh, respectively, to twelfth and thirteenth.

The 787, while small in terms of MRO value today, is expected to grow over 50% year over year through 2024. This should drive it from 32nd to 6th in terms of MRO rank as it grows to over $5B. Its Airbus counterpart, while not currently in service, is expected to grow to over $6B in the same time period.

The Embraer family (with its upgraded E2) is also expected to nearly double its MRO value over the ten-year period. However, by 2024, it should just break the $2B threshold mark, making it just 10% of the largest A320 MRO market size.

In 2014, globally the leading turboprops in terms of MRO market are the ATR 72, Bombardier Q400, and Beech 1900. By 2024 though the ATR 72 is expected to far outpace any other fleet type.

TOP 10 FLEETS BY MRO SIZE

	2014	2024
1*	A320 CEO & NEO	A320 CEO & NEO
2*	737 NG & MAX	737 NG & MAX
3*	777	777
4*	747-400	A350
5*	A330	A330
6	767	787
7	757	A380
8	737 Classics	Embraer 170/175/190/195 & E2
9*	A340	747-400
10	CRJ-700/900/1000	A340

*** denotes aircraft that are in the top ten in 2014 and 2024**

Source: TeamSAI Consulting Services analysis

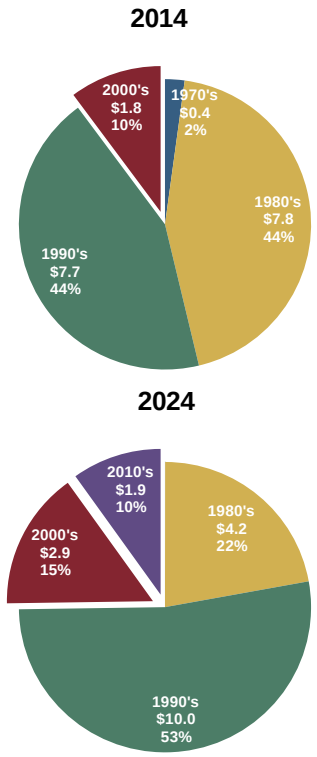
Table 6

Boeing and Airbus aircraft drive nearly 90% of the MRO market.

The A320 (CEO & NEO) and 737 (NG & MAX) are expected to drive the largest share of the MRO market over the forecast period.

The fastest growing fleets in terms of MRO value over the forecast period are the A350, 787, A380, 747-8, and the CSeries

NA MRO FORECAST BY VINTAGE ($USB)



In North America, the newest fleet types (2000's and 2010's) will begin to drive a larger share of MRO by 2024

Source: TeamSAI Consulting Services analysis

Figure 9

Implications for North American MROs

The total MRO market is expected to become increasingly top heavy. In 2014, the top ten airframes comprise 77% of the total MRO market. By 2024 the top ten airframes are expected to represent 81%, picking up four percentage points of market share. Globally, the same trend is expected as the top ten airframe types pick up additional market share by 2024 relative to 2014 estimates.

The implications of the transition described above are that MROs must be prepared to handle the work associated with this changing mix, or focus their strategy to capture declining markets. From an airframe MRO perspective, providers must be able to address the demands of composite airframe materials (specific to the 787 and A350). At the other end of the spectrum, the MD-11 freighters round out the top ten, meaning those with MD-11 capabilities should be well positioned to capitalize on the extended life of these aircraft.

The obvious targets on the narrowbody side are 737 NG/MAX and A320 CEO/NEO. These two families are expected to drive a combined 27% of the market in 2014. More importantly, the same two families are forecast to drive 45% of the market by 2024.

While all the North American widebodies combined are not expected to come close to these two top narrowbodies, six of the top ten families in 2024 in terms of MRO value are widebody aircraft. Moreover, based on publicly-available contract information, TeamSAI estimates that North American operators currently are sending as much as 60% of their widebody heavy maintenance to Asia Pacific and China. (See map in Figure 10.)

By targeting widebody maintenance work through the introduction of capacity and development of the necessary skills, MROs can open a broad market for themselves. Recognizing that the North American and Asian labor rate differential will wane over the forecast period, MROs that build widebody capabilities could be in a position to capture this market from North American operators that have been sending that work abroad.

It will not be a simple task though. Even if labor rate parity is reached, Asian MROs have the capacity and skills in place today. While American MROs do have widebody capability, investment will be needed for training, tooling and equipment. The cost of capital for such expansion will be challenging but necessary to compete with Asian MROs.

New aircraft enjoy a significant honeymoon period, particularly when the engine and component MRO value is low due to long intervals between service and/or long warranty periods. Aircraft of the latter half of the 2000's vintage and the 2010's vintage will experience increased MRO demands in the latter half of the forecast period. For instance, the 787, A350, 737 MAX, A320 NEO, A380, CSeries, MRJs, Embraer E2, and Sukhoi Superjet are expected to ramp up MRO demand from negligible amounts in 2014 to a substantial share by 2024. In total, the 2000's and 2010's vintage fleets will grow from 10% in 2014 to a quarter of the market by 2024. This makes the combined 2000's and 2010's vintage second only to the 1990's vintage dominated by the 737 NGs. (See Figure 9.) As the fleets continue to age beyond the forecast period, MROs with capabilities to service this growing segment will be well positioned for success.

Globally, engine OEMs have captured over 50% of the market based on publicly-available information. North American operators rely even more on

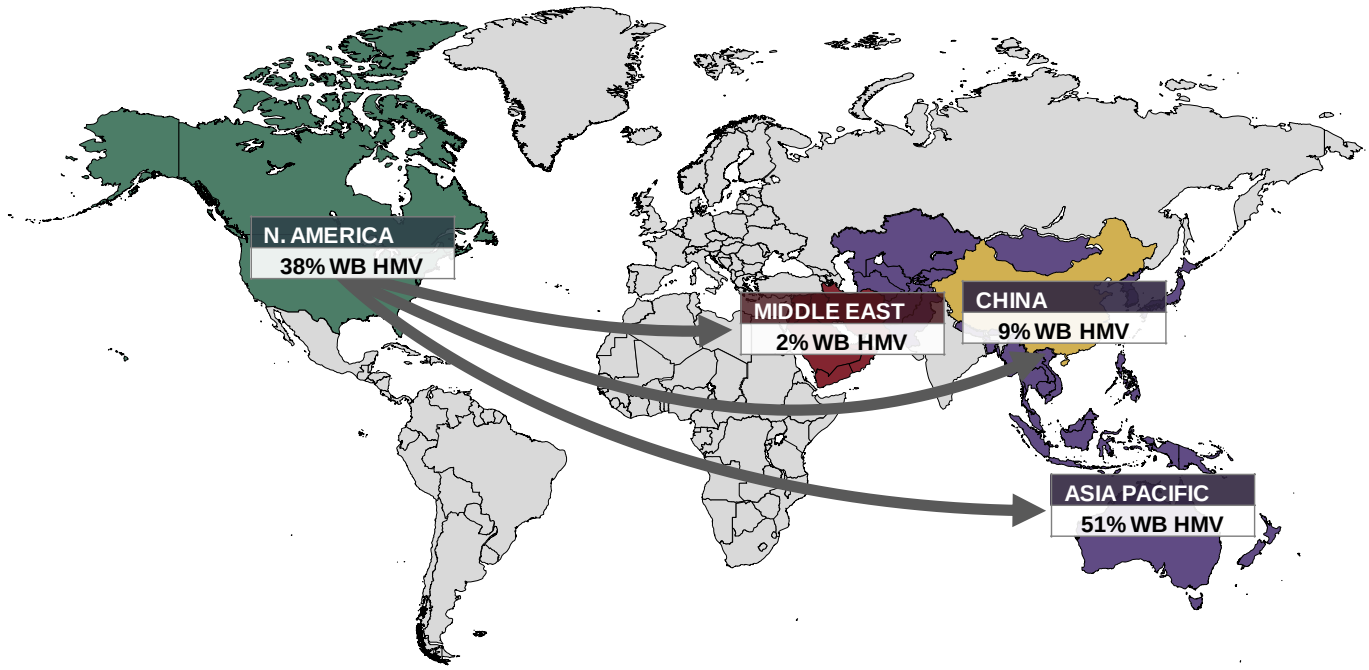
OEMs, sending upwards of 60% of their engine MRO work to OEMs. This represents a serious, and much discussed, challenge for independent engine MRO providers, which often find themselves at a disadvantage.

But aircraft heavy maintenance work represents a brighter picture for the independent MRO (at least the largest ones). TeamSAI estimates that, globally, airlines, airline third-party providers, and independent MROs have captured over 90% of the market, with independent MROs performing as much as 36% of the work. Looking at just the demand from North American operators though, TeamSAI estimates that independent MROs are performing as much as 62% of the known work.

Currently, ST Aerospace is the leading provider of widebody MRO for North American operators. Interestingly, TIMCO, which is in the process of being acquired by HAECO perhaps because it too sees this very opportunity, has positioned itself well. Combined, the two will assume second place among providers of widebody HMV work—although it remains a distant second.

An estimated 62% of North America's HMV work is contracted to providers outside the region.

2014 REPATRIATION OF NORTH AMERICA'S CONTRACTED HMV WORK PRESENTS OPPORTUNITIES



Source: TeamSAI Consulting Services analysis

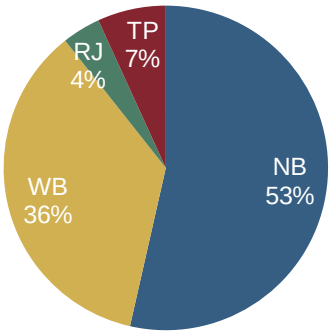
Figure 10

MRO Market by Market Segment

The MRO market can be divided into four main market segments: (1) airframe, (2) engine, (3) component, and (4) line.

2014 AIRFRAME MRO MARKET ($11.5B)

by Aircraft Class



Class	2014	2019	2024
NB	$6.1	$6.7	$8.8
WB	$4.1	$5.1	$7.2
RJ	$0.4	$0.5	$0.4
TP	$0.8	$0.9	$0.8
Total	$11.5	$13.2	$17.2

CAGR	2014	2019	2024
NB	1.9%	5.5%	3.7%
WB	4.5%	7.0%	5.8%
RJ	0.9%	-1.5%	-0.3%
TP	2.1%	-2.2%	-0.1%
Total	2.8%	5.5%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 11

Airframe (HMV and Modifications) Maintenance

Market Size & Forecast

Air transport's labor intensive airframe or heavy maintenance and modifications MRO market is expected to be $11.5B in 2014, which represents 20% of the total MRO spend. (See Figure 11.)

The total airframe market is forecast to increase at a rate of 2.8% CAGR through 2019. It is expected to see notably faster growth (5.5% CAGR) in the following five years as modifications pick back up and the high number of deliveries of the early 2000s return for their second round of heavy visits, at the same time the 2005-2009 and 2010-2014 deliveries begin their first round of HMVs.

In 2014, the global airframe MRO market will be dominated by narrowbody spend. While widebody airframe MRO will increase its share over the forecast period, narrowbody will continue to lead. The regional jet and turboprop airframe MRO spend is expected to struggle to stay flat over the period, as both lose share.

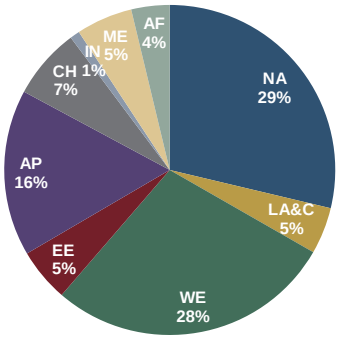
The impact of new RJ programs on the airframe MRO market is expected to be beyond the timeframe of this ten-year forecast; related maintenance events are anticipated in the future though, once these deliveries begin to age. Thus, for the time being, the RJ airframe market is expected to be limited.

Regionally, North America will be the largest market in 2014. While North America is forecast to lose 6 points of market share by 2024, its fleet should continue to drive the largest market in ten years. The fastest growing regions are all in developing areas, led by India, China, the Middle East, and Latin America and the Caribbean. (See Figure 11 and Figure 12.)

The influence of improved technology and increased check intervals in new generation aircraft, particularly the heavy use of composites and the maturing of smart electronics, will influence the heavy maintenance and modifications spend in the latter half of the forecast period. The 787 technology, for example, is anticipated to save some 30-35% over a similar sized, older technology aircraft.

2014 AIRFRAME MRO MARKET BY REGION ($11.5B)

by Region



Region	2014	2019	2024	2014	2019	2024
NA	$3.3	$3.4	$4.0	0.7%	3.2%	1.9%
LA&C	$0.5	$0.8	$1.0	8.3%	5.3%	6.8%
WE	$3.2	$3.3	$3.8	0.4%	3.1%	1.8%
EE	$0.6	$0.7	$0.8	2.3%	4.6%	3.4%
AP	$1.9	$2.3	$3.3	4.4%	7.4%	5.9%
CH	$0.8	$1.1	$1.9	7.2%	10.9%	9.0%
IN	$0.1	$0.2	$0.4	15.7%	13.8%	14.7%
ME	$0.6	$1.0	$1.3	8.9%	6.2%	7.5%
AF	$0.4	$0.4	$0.6	-1.7%	8.4%	3.2%
Total	$11.5	$13.2	$17.2	2.8%	5.5%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 12

Market Structure

Airframe maintenance providers can be classified into five categories. (See Figure 13.)

Airline: Commercial air transport operators that perform maintenance with in-house airframe maintenance capabilities.

Airline Third Party: Maintenance subsidiaries of airlines, often operating with a degree of autonomy and that perform maintenance for other operators and possibly their own parent. These organizations leverage maintenance capabilities at scale to offer competitive pricing to the marketplace.

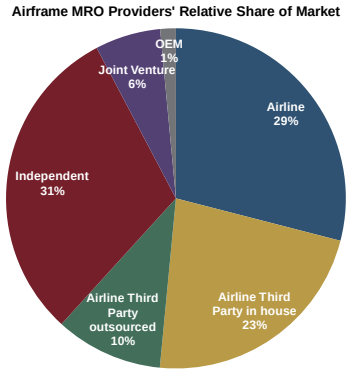
Independent: Dedicated maintenance providers with no relation to either OEMs or airlines. From large to small, these maintenance providers often have lowest labor costs.

Joint Venture: Airframe maintenance providers that are formed by (typically) joining the resources of OEMs and in-country capabilities to build indigenous capacity (e.g., AMECO, Taikoo, GAMECO, etc.).

OEM: Airframe manufacturers, such as Airbus, Boeing, Embraer, Bombardier, Sukhoi, ATR, etc., offering maintenance capabilities for their respective aircraft types.

Based on known, publicly-available information, it is possible to estimate the market share that each market player type enjoys. Interestingly, for all the discussion related to contracting work out, globally, the air transport market still keeps most of its airframe maintenance in-house (52% when combining airline work and the in-house work of airline third party providers). Those airline providers that choose to pursue the maintenance work of other airlines' airframes capture an additional 10%. Independent providers carryout nearly a third of the demand. Joint Ventures (JVs) leverage the resources and skills of existing MROs in developing areas—to date, this represents more than 5% of the market. Finally, OEMs, recognizing the value that the MRO market holds in the lifecycle of their products, have moved to capture a portion of that work for themselves. Currently, OEMs hold a negligible share of the market; however, as new generation aircraft begin to demand maintenance, the efforts of OEMs to sell those aircraft with maintenance packages are expected to add to their share.

2014 AIRFRAME MRO PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 13

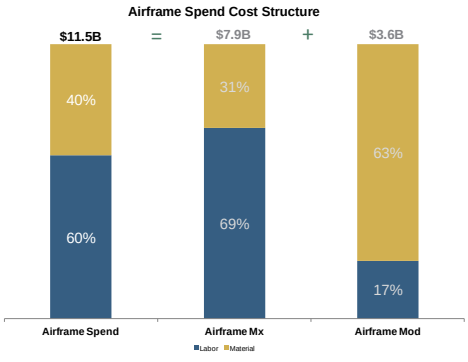
Cost Structure

The airframe spend can be divided into labor and material elements. (See Figure 14.)

- Labor: Labor is the larger element of airframe work. Labor accounts for 60% of the airframe spend. This includes labor for licensed technicians (mechanics or engineers) for all airframe maintenance labor services provided and for related modifications work. It also includes the cost of benefits and overhead. When differentiating between airframe and modifications work, labor represents 69% and 17%, respectively.
- Material: Material is the smaller element of airframe work. Material accounts for 40% of the airframe spend. This includes all materials and consumables. When differentiating between airframe and modifications work, material represents 31% and 63%, respectively. Clearly, the nature of modifications work drives a higher emphasis on materials.

Little change in this mix is expected over the forecast period.

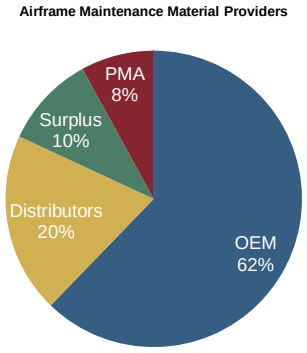
2014 AIRFRAME LABOR/MATERIAL MIX



Source: TeamSAI Consulting Services analysis

Figure 14

2014 AIRFRAME MATERIAL PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 15

Supply Chain

The airframe maintenance material supply chain consists of four main sources: OEMs, distributors, surplus providers, and PMA providers. (See Figure 15.)

- OEMs: Original equipment manufacturers represent more than 60% of the airframe maintenance material parts market.
- Distributors: As intermediaries between the parts manufacturers and maintenance providers, distributors represent about one-fifth of the material parts demand.
- Surplus providers: Surplus providers, which purchase new and used material from other surplus providers, MROs, operators, and/or directly from parted-out aircraft, constitute 10% of the airframe maintenance parts demand.
- PMA providers: PMA providers, despite significant barriers, have made some inroads into the airframe maintenance market, providing some 8% of the material. Looking to the future, while PMA currently represents the smallest share, some large PMA providers have implemented strategies which are expected to yield significant gains because of their attractiveness to airline customers focused on cost reductions.

Engine Maintenance

Market Size & Forecast

The engine MRO market is forecast to be $22.1B or 38% of total MRO spend in 2014.

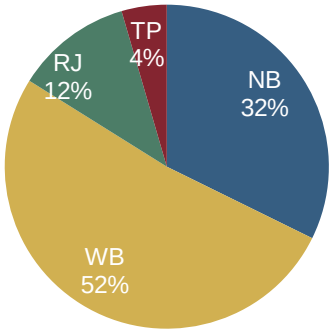
It is forecast to grow at 6.2% over the next five years, then at a much slower 2.1% per year over the following five-year period, for a total ten-year growth rate of 4.1% per year. This growth rate is rather restrained compared to several years ago, especially for the second half of the forecast period. Despite the poorer performance in the second half of the forecast, the full forecast period growth rate makes it among the fastest growing segments because of the increasing value engine MRO captures. (See Figure 16.)

In 2014, unlike other market segments, the global engine MRO market will be led by widebody spend. Widebody engine MRO is expected to constitute more than half the market spend. Importantly, this dominance should be furthered as the widebody market grows its share. Narrowbody engine MRO, at nearly one-third of the market in 2014, is also expected to grow its share by 2024, particularly as the next-generation narrowbodies enter the market. The regional jet engine MRO spend could decline as much as $1B by 2024, as it sheds 7 points of market share. The turboprop engine MRO spend is expected to grow, but it should still lose pace to the narrowbody and widebody fleets' growth.

North America is expected to be the largest market in 2014, but Asia Pacific is expected to rank first by 2024. This spells a loss of 10 points in market share for North America over the ten-year period. Asia Pacific's engine MRO is expected to grow substantially faster in the first half of the forecast than the second half. In fact, this slower second half growth rate is expected across all regions, which is largely attributed to the increased share of more efficient aircraft powered by longer-on-wing engines. (See Figure 17.)

2014 ENGINE MRO MARKET ($22.1B)

by Aircraft Class



Class	2014	2019	2024
NB	$7.1	$10.7	$12.0
WB	$11.4	$15.9	$18.4
RJ	$2.6	$2.1	$1.6
TP	$1.0	$1.2	$1.3
Total	$22.1	$29.9	$33.2

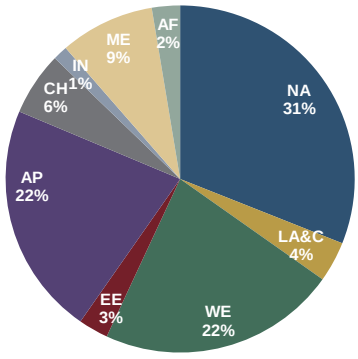
CAGR	2014	2019	2024
NB	8.4%	2.3%	5.3%
WB	6.8%	2.9%	4.9%
RJ	-4.2%	-5.3%	-4.8%
TP	4.5%	0.4%	2.4%
Total	6.2%	2.1%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 16

2014 ENGINE MRO MARKET BY REGION ($22.1B)

by Region



Region	2014	2019	2024	2014	2019	2024
NA	$6.9	$7.0	$6.8	0.4%	-0.5%	0.0%
LA&C	$0.8	$1.3	$1.9	9.8%	7.5%	8.7%
WE	$4.9	$6.1	$6.0	4.4%	-0.2%	2.1%
EE	$0.6	$1.0	$1.4	11.0%	6.5%	8.7%
AP	$4.8	$7.0	$7.3	7.8%	0.8%	4.3%
CH	$1.3	$2.7	$3.9	16.0%	7.5%	11.6%
IN	$0.3	$0.5	$0.8	11.6%	9.6%	10.6%
ME	$1.9	$3.3	$4.0	10.8%	4.0%	7.3%
AF	$0.6	$0.9	$1.0	10.0%	1.8%	5.8%
Total	$22.1	$29.9	$33.2	6.2%	2.1%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 17

In 2014 the largest engine fleets (in terms of engine MRO) are the CF6-80C2, GE90, and CFM56-7B, each driving more than $2B in MRO. This represents some 10% of the market, for each engine type. The top ten engine variants constitute more than two-thirds of the market.

By the end of the forecast period though, the CFM56-7B, which has the largest fleet by far even today, is expected to require more than $5B in MRO services. To reach this level of spend, its market share will have to grow by 7 points to 17%. This engine, which powers the Boeing 737NG, should have a fleet that exceeds 12,000 units.

Over this period, the -80C2 will fall to ninth in terms of MRO demand, and the Trent XWB and GE90 engines should assume the second and third ranking. The Trent XWB, which is dedicated to the Airbus A350, is especially noteworthy because its growth will come entirely within the forecast period.

In 2024 more than three-quarters of the market's MRO will be concentrated in the top ten engine types. The top twenty engine variants are expected to drive 94% of the engine MRO demand.

CF6-80C2, GE90, and CFM56-7B currently drive as much as 30% of the engine MRO market.

The Leap engines which power the NEO (in part) among others is not expected to drive much engine MRO demand over the forecast period. Pratt & Whitney's PW1000G though, which has much broader implementation, is expected to drive nearly $600M in spend, although this represents just 2% of the market in 2024.

By 2024 though, the CFM56-7B alone is estimated to command upwards of 17% of the market.

Looking just at the engines powering the regional jet fleet, in 2014 the five largest fleets (in terms of MRO value) are the CF34-8, CF34-3, AE3007, CF34-10, and Tay. The CF34-8 is the only regional jet engine expected to drive more than $1B in MRO demand; this represents nearly half of the engine MRO market for all regional jets. These top five engines represent 97% of the total engine MRO market. By 2024, the top five engines in terms of MRO value (the CF34-10, CF34-8, PW1000G, CF34-3, and the SaM146) are expected to drive 95% of the market. Of the engines in the top five in 2014, the Tay should be retired by 2024 and the AE3007 should be reduced by 80% of its 2014 demand.

Among turboprops, the PW100, which is the largest fleet by far, not surprisingly is expected to be the largest in terms of MRO value in 2014; this engine should maintain, if not further, its share by 2024.

Engine costs reflect the continued increases in annual material pricing, modestly offset by PMA influences and higher on-wing life as engines mature. Concentration of pricing power in the engine MRO value chain with the engine OEMs remains a commanding driver in the engine MRO market.

The price of fuel and additional environment-related issues (brought on in part as the European Union Emissions Trading Scheme (EU ETS) which should come into force for *all* airlines flying *within* the EU sometime during the forecast period, pending the implementation of an International Civil Aviation Organization (ICAO)-wide scheme), are expected to drive a continued push for better engine designs and new drop-in fuels (as well as overall aircraft and air traffic control systems designs).

Although the effects of these changes on the engine MRO market remain uncertain, it will surely require continued improvement in engine performance and care. This alone will impact the engine MRO market.

Market Structure

Engine maintenance providers can be classified into five categories. (See Figure 18.)

Airline: Commercial air transport operators that perform maintenance with in-house engine maintenance capabilities. Generally, this is limited to operators that have a large enough fleet and experience to merit conducting engine maintenance for themselves.

Airline Third Party: Maintenance subsidiaries of airlines, often operating with a degree of autonomy and that perform maintenance for other operators and possibly their own parent. These organizations leverage maintenance capabilities at scale to offer competitive pricing to the marketplace.

Independent: Dedicated maintenance providers with no relation to either OEMs or airlines. From large to small, these maintenance providers often have lowest labor costs.

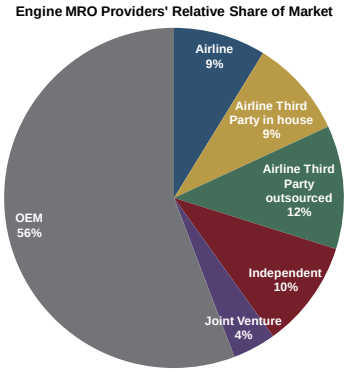
Joint Venture: Airframe maintenance providers that are formed (typically) by joining the resources of OEMs and in-country capabilities to build indigenous capacity (e.g., TAESL, HAESL, AMECO, Turkish Engine Center, Shanghai P&W, etc.).

OEM: Engine manufacturers, such as GE, CFM, Rolls Royce, Pratt & Whitney, Snecma, IAE, etc., offering maintenance capabilities for their respective engine types.

Based on known, publicly-available information, it is possible to estimate the market share that each market player type enjoys. In the air transport segment, OEMs are by far the dominant player in the engine MRO space, controlling more than half the market. Airlines manage just under 20% of the market themselves (when combining airline work and the in-house work of airline third party providers). Airline third party providers servicing other airlines' engines tack on another 13%.

Independent providers capture just 10% of the market, though it will be interesting to see how their collective effort to obtain more and better repair information from OEMs improves their share. JVs, which benefit from their OEM connections, control just 4% of the repair. For the foreseeable future, it seems that OEMs are sure to maintain a strong hold on this market.

2014 ENGINE MRO PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 18

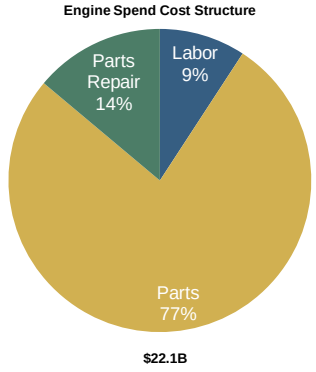
Cost Structure

The engine spend can be divided into three elements: labor, parts, and parts repair. (See Figure 19.)

- Labor: Labor (excluding parts repair) is the smallest element of engine work. Labor accounts for just 9% of the engine spend. This includes direct labor for all engine maintenance labor services including disassembly, inspection, repair, reassembly, and testing. It also includes the cost of benefits and overhead.
- Parts: Parts (or materials) represents, by far, the largest element of engine overhaul work. Materials can be new or surplus parts (from the OEM or a PMA provider) or used parts (after refurbishment).
- Parts repair: Parts repair refers to the costs associated with refurbishing used parts to a serviceable state.

Little change in this mix is expected over the forecast period. However, as many particular engines age, their material costs may decline as alternative parts are developed and improved repair processes are implemented.

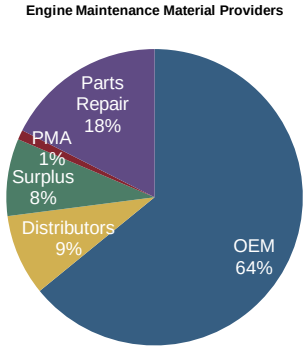
2014 ENGINE LABOR/MATERIAL MIX



Source: TeamSAI Consulting Services analysis

Figure 19

2014 ENGINE MATERIAL PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 20

Supply Chain

The engine overhaul maintenance material supply chain consists of five main sources: OEMs, distributors, surplus providers, PMA providers, and (because of the significant material involved) parts repair providers. (See Figure 20.)

- OEMs: Original equipment manufacturers, not unrelated to their dominance in the engine MRO market as a whole, provide nearly two-thirds of the engine overhaul material parts market.
- Distributors: As intermediaries between the parts manufacturers and maintenance providers, distributors represent about 9% of the material parts demand.
- Surplus providers: Surplus providers, which purchase new and used material from other surplus providers, MROs, operators, and/or directly from parted-out aircraft, constitute 8% of the engine maintenance parts demand.
- PMA providers: PMA providers have encountered especially significant challenges in the penetration of the engine parts space. This market segment is expected to remain a challenge for engine PMA providers, potentially leading to even less PMA content as the fleet grows.
- Parts repair providers: Because engine material is such a significant share of the cost of engine repair, parts repair providers are included separately and approach nearly one-fifth of the material cost.

Component Maintenance

Market Size & Forecast

Component maintenance, consisting of work on such equipment as auxiliary power units (APUs), avionics, wheel/brakes, landing gear, flight controls, structures, equipment/furnishings, cabin systems, etc., represents a $12.2B segment of the MRO activity or 21% of the total. (See Figure 21.)

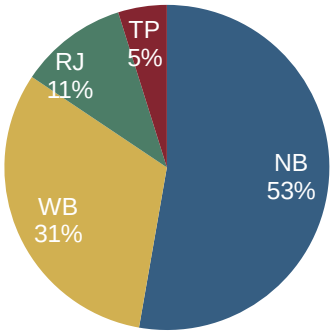
Component MRO, not unlike engine MRO, represents an area where the value continues to grow because of the relative concentration of power in the value chain among a smaller set of major competitors.

The market is expected to grow at 4.8% over the first five-year period and 4.1% over the second five-year period, for a total growth of 4.4% over the entire period.

Regionally, North America will be the largest market in 2014 and continue to hold that position by the end of the forecast. However, the region's growth is nearly flat at 0.4%. Consequently, North America is forecast to lose 9 points of market share by 2024, as developing regions gain share. Not surprisingly, the fastest growing regions are all in developing areas, led by India, China, the Middle East, and Latin America and the Caribbean. (See Figure 22.)

2014 COMPONENT MRO MARKET ($12.2B)

by Aircraft Class



Class	2014	2019	2024
NB	$6.4	$8.6	$11.0
WB	$3.8	$4.7	$5.7
RJ	$1.3	$1.4	$1.3
TP	$0.6	$0.7	$0.8
Total	$12.2	$15.3	$18.7

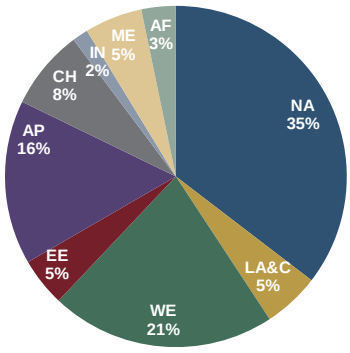
CAGR	2014	2019	2024
NB	6.1%	5.0%	5.5%
WB	3.9%	4.0%	3.9%
RJ	0.7%	-1.1%	-0.2%
TP	3.8%	1.7%	2.7%
Total	4.8%	4.1%	4.4%

Source: TeamSAI Consulting Services analysis

Figure 21

2014 COMPONENT MRO MARKET BY REGION ($12.2B)

by Region



Region	2014	2019	2024	2014	2019	2024
NA	$4.3	$4.4	$4.5	0.3%	0.5%	0.4%
LA&C	$0.7	$1.0	$1.3	8.2%	6.6%	7.4%
WE	$2.6	$3.1	$3.4	3.8%	2.0%	2.9%
EE	$0.6	$0.8	$1.0	7.3%	5.2%	6.2%
AP	$1.9	$2.7	$3.4	7.0%	5.2%	6.1%
CH	$0.9	$1.5	$2.3	10.7%	8.0%	9.4%
IN	$0.2	$0.3	$0.6	13.5%	11.2%	12.4%
ME	$0.7	$1.0	$1.4	8.7%	7.0%	7.9%
AF	$0.4	$0.5	$0.7	6.8%	6.2%	6.5%
Total	$12.2	$15.3	$18.7	4.8%	4.1%	4.4%

Source: TeamSAI Consulting Services analysis

Figure 22

Market Structure

Component maintenance providers can be classified into five categories. (See Figure 23.)

Airline: Commercial air transport operators that perform maintenance with in-house component maintenance capabilities. Generally, this is limited to operators that have a large enough fleet and experience to merit conducting component maintenance for themselves.

Airline Third Party: Maintenance subsidiaries of airlines, often operating with a degree of autonomy and that perform maintenance for other operators and possibly their own parent. These organizations developed to leverage maintenance capabilities at scale to offer competitive pricing to the marketplace.

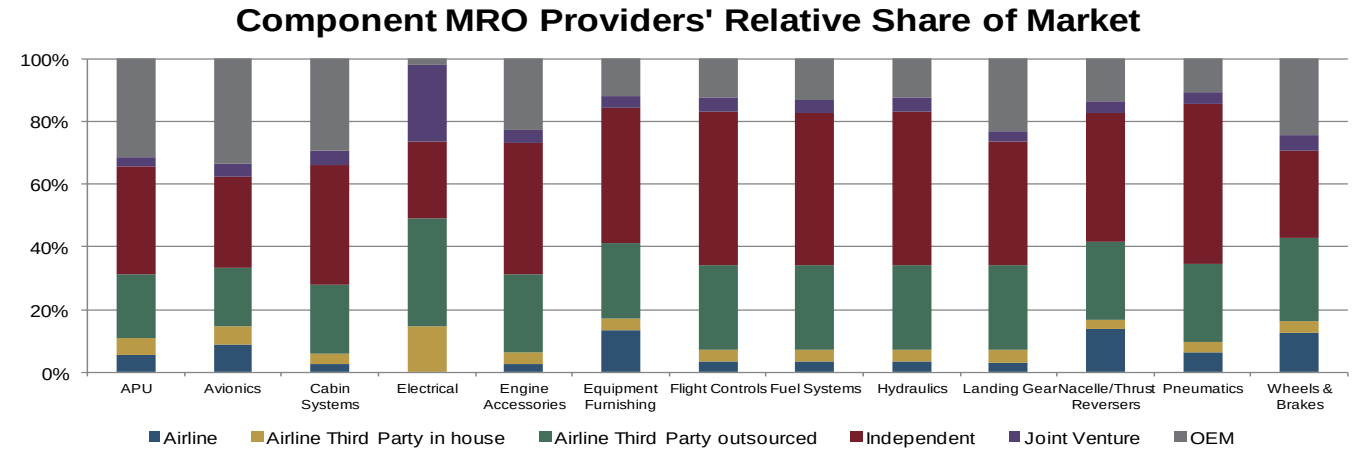
Independent: Dedicated maintenance providers with no relation to either OEMs or airlines. From large to small, these maintenance providers often have lowest labor costs.

Joint Venture: Component maintenance providers that are formed by (typically) joining the resources of OEMs and in-country capabilities to build indigenous capacity (e.g., AMECO, CAMSSL, GAMECO, OEM Services, Spairliners, TAECO, etc.).

OEM: Component manufacturers, such as BAE, Eaton, UTC-Aerospace Systems Goodrich, UTC-Aerospace Systems Hamilton Sundstrand, Honeywell, Meggitt, Messier, Panasonic, Rockwell Collins, Thales, etc., offering maintenance capabilities for their respective component parts.

Based on known, publicly-available information, it is possible to estimate the market share that each market player type enjoys. In the air transport segment, OEMs are by far the dominant player in the component MRO space for the most complex component types. Airlines (along with their affiliated third party providers) and independent MROs enjoy notable shares as well.

2014 COMPONENT MRO PROVIDERS



Source: TeamSAI Consulting Services analysis

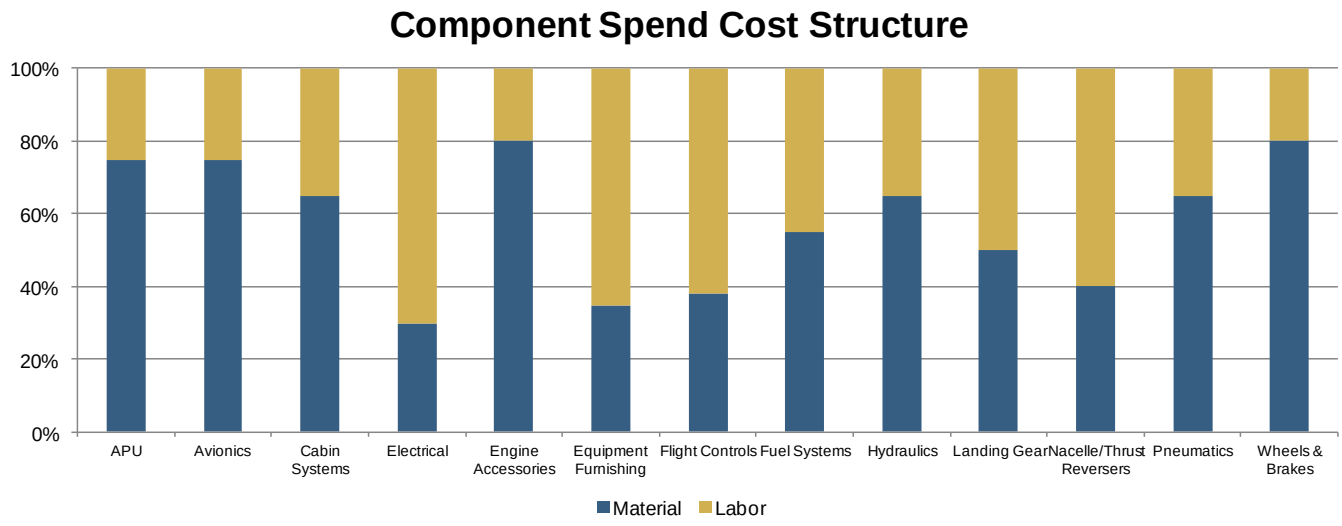
Figure 23

Cost structure

The component spend can be divided into two elements: labor and material. The cost structure split between labor and material depends on the component type. (See Figure 24.)

- Labor: Labor is the smaller element of component work for the most part.
- Material: With a few exceptions, material tends to represent the larger share of the component MRO spend. This is especially true of wheels and brakes, APU, and avionics

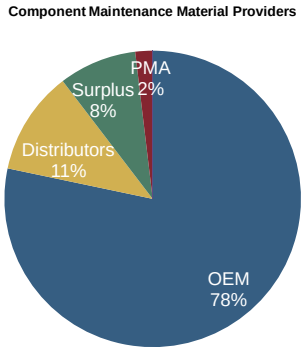
2014 COMPONENT MRO LABOR/MATERIAL MIX



Source: TeamSAI Consulting Services analysis

Figure 24

2014 COMPONENT MAT'L PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 25

Supply Chain

The component maintenance material supply chain consists of four main sources: OEMs, distributors, surplus providers, and PMA providers. (See Figure 25.)

- OEMs: Original equipment manufacturers in the component MRO segment provider nearly 80% of the material.
- Distributors: As intermediaries between the parts manufacturers and maintenance providers, distributors represent about 11% of the material parts demand.
- Surplus providers: Surplus providers, which purchase new and used material from other surplus providers, MROs, operators, and/or directly from parted-out aircraft, constitute 8% of the component maintenance parts demand.
- PMA providers: Similar to engine PMA providers, component PMA providers are expected to struggle as the fleet grows. But because of the different types of components, some being less complex in design, PMA may see marginally better success.

Line Maintenance

Market Size & Forecast

Line maintenance represents an $11.9B segment of the MRO activity or 21% of the total. (See Figure 26.)

This segment is expected to grow at 4.5% over the first five-year period and 3.6% over the second five-year period, for a total growth of 4.1% over the entire period.

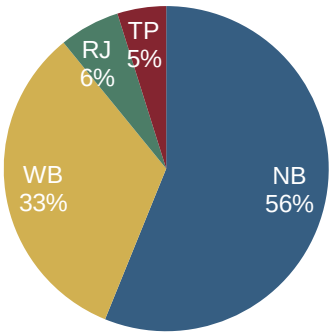
Most carriers still control their own line maintenance and this characteristic is not expected to change dramatically. Increased contracting at locations where airlines have limited flight schedules, however, represents a growth opportunity for third-party providers who are working to expand their coverage. (See Figure 26 and Figure 27.)

In 2014, the global line MRO market will be dominated by narrowbody spend, and this dominance should continue into the future. Widebody airframe MRO should grow at a comparable rate as that of narrowbody aircraft, but it will command roughly the same share in 2024. The regional jet line MRO spend is expected to struggle to stay flat over the period. Turboprop line MRO spend is forecast to increase moderately. Both regional jet and turboprop line MRO are expected to see a decline in market share.

Regionally, North America is expected to be the largest market in 2014 but should yield that position to Western Europe by 2024. Both Western Europe and North America are forecast to lose market share by 2024 though, as developing regions erode the share of developed areas. (See Figure 27.)

2014 LINE MRO MARKET ($11.9B)

by Aircraft Class



Class	2014	2019	2024
NB	$6.7	$8.5	$10.2
WB	$3.9	$4.9	$6.0
RJ	$0.7	$0.8	$0.7
TP	$0.6	$0.7	$0.7
Total	$11.9	$14.8	$17.7

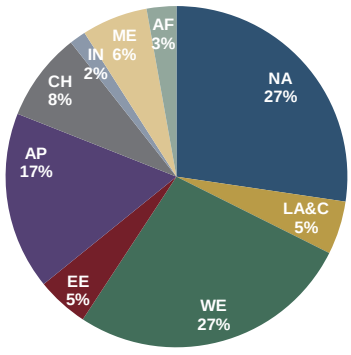
CAGR	2014	2019	2024
NB	4.9%	3.8%	4.3%
WB	4.6%	4.2%	4.4%
RJ	1.5%	-0.9%	0.3%
TP	2.8%	1.6%	2.2%
Total	4.5%	3.6%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 26

2014 LINE MRO MARKET BY REGION ($11.9B)

by Region



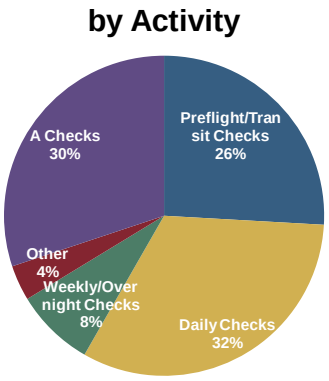
Region	2014	2019	2024	2014	2019	2024
NA	$3.3	$3.5	$3.7	1.5%	1.1%	1.3%
LA&C	$0.6	$0.8	$1.1	7.0%	5.3%	6.2%
WE	$3.2	$3.6	$4.0	2.6%	2.1%	2.4%
EE	$0.6	$0.8	$1.0	7.0%	4.4%	5.7%
AP	$2.0	$2.7	$3.2	5.8%	3.6%	4.7%
CH	$1.0	$1.5	$2.1	8.4%	7.3%	7.9%
IN	$0.2	$0.3	$0.5	12.6%	9.8%	11.2%
ME	$0.7	$1.1	$1.4	7.4%	5.8%	6.6%
AF	$0.3	$0.5	$0.6	6.4%	5.5%	6.0%
Total	$11.9	$14.8	$17.7	4.5%	3.6%	4.1%

Source: TeamSAI Consulting Services analysis

Figure 27

Daily checks constitute the largest segment of the market, at 32%. Transit checks, which are also very frequent, command another 26% of the market. A checks, which are less frequent but relatively more maintenance-intensive, make up 30% of the market. (See Figure 28.)

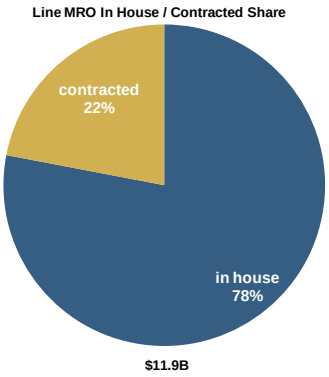
2014 LINE MRO BY ACTIVITY



Source: TeamSAI Consulting Services analysis

Figure 28

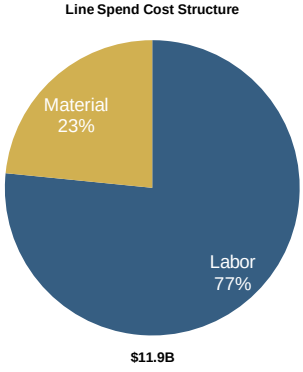
2014 LINE MRO CONTRACTED/INHOUSE



Source: TeamSAI Consulting Services analysis

Figure 29

2014 LINE LABOR/MATERIAL MIX



Source: TeamSAI Consulting Services analysis

Figure 30

Market Structure

Line maintenance is typically either performed by the operator or contracted out. (See Figure 29.)

While most programs are fairly standardized for given airframe types, different aircraft and different flight profiles can dictate different needs. Moreover, line maintenance requirements will gradually increase as the rate of technical defects and discrepancies climbs.

Most line maintenance is performed at the gate or ramp and is done to maintain the operational performance of the aircraft.

Because of its importance in keeping an aircraft airworthy for daily operations, operators seek to control line maintenance carefully, often performing the bulk of the work in-house and contracting emergency on-call maintenance at non-hub stations. Compared to the other sectors though, contract line maintenance is less common.

An operator's decision to contract line maintenance is often tied to locations where the operator has limited capacity, particularly at airports removed from the main network. Such situations represent opportunities for contract line maintenance providers.

Based on known, publicly-available information, it is possible to estimate the share of the market that is in-house and contracted. (See Figure 29.) In the air transport segment, airlines conduct most of their own line maintenance for themselves. Nearly 80% of the demand is carried out in-house. When contracting line maintenance out, operators look to those providers that have experience for the aircraft in transit. Key considerations include: (1) reputation; (2) the ability to provide Aircraft On Ground (AOG) service; (3) spares availability; (4) turnaround times; and (5) labor rates (especially given that line maintenance labor rates tend to be higher than that of airframe heavy maintenance rates).

Cost Structure

The line spend can be divided into two elements: labor and material. (See Figure 30.)

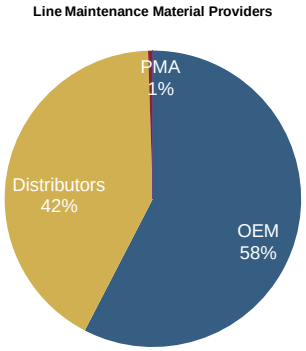
- Labor: Labor is the major element of line work, constituting more than three quarters of total spend. Skilled labor is required to inspect, troubleshoot, remove, and replace parts as needed.
- Material: Material tends to represent the smaller of the line MRO spend, driving just less than a quarter. Line maintenance material spend tends to be dominated by expendables and consumables. Repairable and rotable component repair costs, even if replaced during line maintenance, are captured in the component MRO segment.

Supply Chain

The nature of line maintenance suggests that it contains elements of airframe and component parts. The supply chain consists of three main sources: OEMs, distributors, and PMA providers. Line maintenance also requires consumable materials, such as oil and solvent, for the regular maintenance. (See Figure 31.)

- OEMs: Original equipment manufacturers represent nearly 60% of the line maintenance material parts market. These manufacturers higher value materials drive their share of the market.
- Distributors: As intermediaries between the parts manufacturers and maintenance providers, distributors represent about 40% of the market.
- PMA providers: PMA providers represent a small share of line maintenance. However, the potential for such parts in minor structural work as part of A checks, etc, suggests there is room for more PMA penetration here, especially as airlines seek cost savings.

2014 LINE MATERIAL PROVIDERS



Source: TeamSAI Consulting Services analysis

Figure 31

GLOBAL MRO BALANCE OF TRADE

The following discusses the supply and demand of MRO services in the major world regions. Comparing the relative amounts of supply and demand provides an estimate of the balance of trade.

To determine the relative supply of MRO services based on the forecasted demand each operator generates in each segment, publicly-available contract information is compiled at the fleet type level. This data is analyzed then at the regional level to assess the balance of trade.

An example is helpful to explain the net importer/net exporter definitions:

North America is a net importer of airframe services because the MRO demand that North American operators send abroad exceeds the value of MRO services North American MROs supply for operators in other regions.

A few definitions are important to clearly convey this analysis.

- **net importer**: a region whose value of imported MRO work is higher than its value of exported MRO work over a given period of time
- **net exporter**: a region whose value of exported MRO work is higher than its value of imported MRO work over a given period of time
- **imported MRO work**: MRO work the operator sends outside its home region; essentially, the operator is *im*porting the MRO service, even though it must physically send the airframe/engine/component outside its home region
- **exported MRO work**: MRO work supplied in a given region for other regions' operators; essentially the MRO is *ex*porting its MRO service, even though it must physically bring the airframe/engine/component into its home region

Note: the decision as to whether a region is a net importer or net exporter is independent of the amount of work MROs do for operators within their region

In total (i.e., combining all airframe, engine, and component MRO supply and demand), North America and Western Europe are net exporters of MRO services because the MRO demand that North American and Western European operators send abroad is less than the value of MRO services North American and Western European MROs supply for operators in other regions. Latin America and the Caribbean, Eastern Europe, Asia Pacific, China, India, the Middle East, and Africa are net importers of MRO services.

REGIONAL EX-/IMPORTER – AIRFRAME

Region	Net Exporter/Importer
NA	net importer
LA&C	net exporter
WE	net exporter
EE	net importer
AP	net exporter
CH	net exporter
IN	net importer
ME	net exporter
AF	net importer

Source: TeamSAI Consulting Services analysis

Table 7

Airframe (excluding modifications)

North American (NA) operators generate $2.4B in airframe maintenance (excluding modifications) demand. 77% of this demand is met by airframe MRO providers in North America. Approximately $568M of this airframe maintenance demand is performed in regions outside North America, and an additional $66M is conducted for other regions. This results in a total of $1.9B of airframe maintenance (excluding modifications) supplied by North American airframe maintenance providers. Thus, North America is a net importer of airframe maintenance services.

Latin America & the Caribbean (LA&C) is a net exporter of airframe maintenance services. LA&C operators generate $354M in airframe maintenance demand. 90% of this demand is met by airframe MRO providers in Latin America. Approximately $34M of this airframe maintenance demand is performed in regions outside Latin America, and an additional $142M is conducted for other regions. This results in a total of $462M of airframe maintenance (excluding modifications) supplied by Latin American airframe maintenance providers.

Western Europe (WE) is a net exporter of airframe maintenance services. Western European operators generate $2.1B in airframe maintenance demand. 88% of this demand is met by airframe MRO providers in Western Europe. Approximately $248M of this airframe maintenance demand is performed in regions outside Western Europe, and an additional $400M is conducted for other regions. This results in a total of $2.2B of airframe maintenance (excluding modifications) supplied by Western European airframe maintenance providers.

Eastern Europe (EE) is a net importer of airframe maintenance services. Eastern European operators generate $414M in airframe maintenance demand. Just 17% of this demand is met by airframe MRO providers in Eastern Europe. Approximately $343M of this airframe maintenance demand is performed in regions outside Eastern Europe, and an additional $78M is conducted for other regions. This results in a total of $149M of airframe maintenance (excluding modifications) supplied by Eastern European airframe maintenance providers.

Asia Pacific (AP) is a net exporter of airframe maintenance services. Asia Pacific operators generate $1.3B in airframe maintenance demand. As much as 93% of this demand is met by airframe MRO providers in Asia Pacific. Approximately $99M of this airframe maintenance demand is performed in regions outside Asia Pacific, and an additional $540M is conducted for other regions. This results in a total of $1.8B of airframe maintenance (excluding modifications) supplied by Asia Pacific airframe maintenance providers.

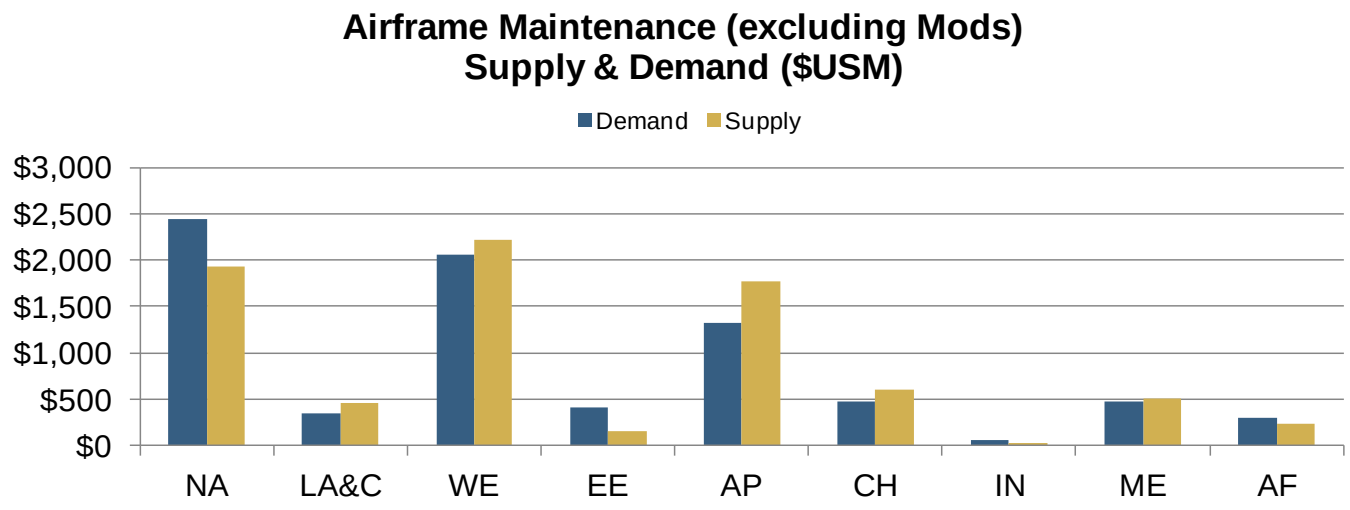
China (CH) is a net exporter of airframe maintenance services. Chinese operators generate $478M in airframe maintenance demand. 91% of this demand is met by airframe MRO providers in China. Approximately $41M of this airframe maintenance demand is performed in regions outside China, and an additional $164M is conducted for other regions. This results in a total of $601M of airframe maintenance (excluding modifications) supplied by Chinese airframe maintenance providers.

India (IN) is a net importer of airframe maintenance services. Indian operators generate $66M in airframe maintenance demand. Just 32% of this demand is met by airframe MRO providers in India. Approximately $45M of this airframe maintenance demand is performed in regions outside India. This results in a total of $21M of airframe maintenance (excluding modifications) supplied by Indian airframe maintenance providers.

Middle East (ME) is a net exporter of airframe maintenance services. Middle Eastern operators generate $470M in airframe maintenance demand. 87% of this demand is met by airframe MRO providers in the Middle East. Approximately $60M of this airframe maintenance demand is performed in regions outside the Middle East, and an additional $104M is conducted for other regions. This results in a total of $515M of airframe maintenance supplied by Middle Eastern airframe maintenance providers.

Africa (AF) is a net importer of airframe maintenance services. African operators generate $296M in airframe maintenance demand. 70% of this demand is met by airframe MRO providers in Africa. Approximately $89M of this airframe maintenance demand is performed in regions outside Africa, and an additional $33M is conducted for other regions. This results in a total of $240M of airframe maintenance (excluding modifications) supplied by African airframe maintenance providers. (See Figure 32 and Table 8.)

2014 AIRFRAME MAINTENANCE BALANCE OF TRADE



Source: TeamSAI Consulting Services analysis

Figure 32

2014 AIRFRAME MAINTENANCE BALANCE OF TRADE: WHERE REGIONS HAVE MAINTENANCE PERFORMED

Region	Demand by Operator Region ($USM)	Supplier Region								
		NA	LA&C	WE	EE	AP	CH	IN	ME	AF
NA	$2,435	77%	4%	1%	0%	15%	2%	0%	1%	0%
LA&C	$354	4%	90%	5%	0%	0%	0%	0%	0%	0%
WE	$2,066	1%	1%	88%	4%	3%	2%	0%	1%	1%
EE	$414	1%	4%	48%	17%	0%	16%	0%	9%	4%
AP	$1,326	1%	0%	5%	0%	93%	1%	0%	0%	0%
CH	$478	1%	0%	0%	0%	7%	91%	0%	0%	0%
IN	$66	0%	0%	20%	0%	32%	1%	32%	14%	0%
ME	$470	0%	0%	8%	0%	4%	0%	0%	87%	1%
AF	$296	6%	0%	12%	0%	8%	4%	0%	1%	70%
Total	**$7,905**									

Source: TeamSAI Consulting Services analysis

Table 8

Engine

Most engine OEMs are located in North America and Western Europe. Given the OEM dominance in the engine MRO market, it is no surprise that these regions are the largest suppliers of such services. (See Figure 33 and Table 10.)

North American (NA) operators generate $6.9B in engine overhaul demand. 84% of this demand is met by engine MRO providers in North America. Approximately $1.1B of this engine maintenance demand is performed in regions outside North America, and an additional $4.9B is conducted for other regions. This results in a total of $10.7B of engine maintenance supplied by North American engine maintenance providers. Thus, North America is a net exporter of engine overhaul maintenance services.

Latin America & the Caribbean (LA&C) is a net importer of engine overhaul maintenance services. LA&C operators generate $835M in engine maintenance demand. Just 2% of this demand is met by engine MRO providers in Latin America. Approximately $820M of this engine maintenance demand is performed in regions outside Latin America (namely North America). It appears that LA&C is attracting very little engine work from abroad. This results in a total of just $15M of engine maintenance supplied by LA&C engine maintenance providers.

Western Europe (WE) operators generate $4.9B in engine overhaul demand. 69% of this demand is met by engine MRO providers in Western Europe. Approximately $1.5B of this engine maintenance demand is performed in regions outside Western Europe, and an additional $4.6B is conducted for other regions. This results in a total of $7.9B of engine maintenance supplied by Western Europe engine maintenance providers. Thus, Western Europe is a net exporter of engine overhaul maintenance services.

Eastern Europe (EE) is a net importer of engine overhaul maintenance services. Eastern European operators generate $614M in engine maintenance demand. Just 1% of this demand is met by engine MRO providers in Eastern Europe. Approximately $607M of this engine maintenance demand is performed in regions outside Eastern Europe (primarily Western Europe). It appears that Eastern Europe is attracting very little engine work from abroad. This results in a total of just $7M of engine maintenance supplied by Eastern European engine maintenance providers.

Asia Pacific (AP) operators generate $4.8B in engine overhaul demand. 39% of this demand is met by engine MRO providers in Asia Pacific. This likely will continue to grow as Asia Pacific builds its engine MRO capacity. Approximately $2.9B of this engine maintenance demand is performed in regions outside Asia Pacific, and an additional $685M is conducted for other regions. This results in a total of $2.6B of engine maintenance supplied by Asia Pacific engine maintenance providers. Thus, Asia Pacific is a net importer of engine overhaul maintenance services.

China (CH) is a net importer of engine overhaul maintenance services. Chinese operators generate $1.3B in engine overhaul demand. 19% of this demand is met by engine MRO providers in China. Approximately $1.1B of this engine maintenance demand is performed in regions outside China, and an additional $133M is conducted for other regions. This results in a total of $380M of engine maintenance supplied by Chinese engine maintenance providers.

India (IN) is a net importer of engine overhaul maintenance services. Indian operators generate $301M in engine overhaul demand. 35% of this demand is

REGIONAL EX-/IMPORTER – ENGINE

Region	Net Exporter/Importer
NA	net exporter
LA&C	net importer
WE	net exporter
EE	net importer
AP	net importer
CH	net importer
IN	net importer
ME	net importer
AF	net importer

Source: TeamSAI Consulting Services analysis

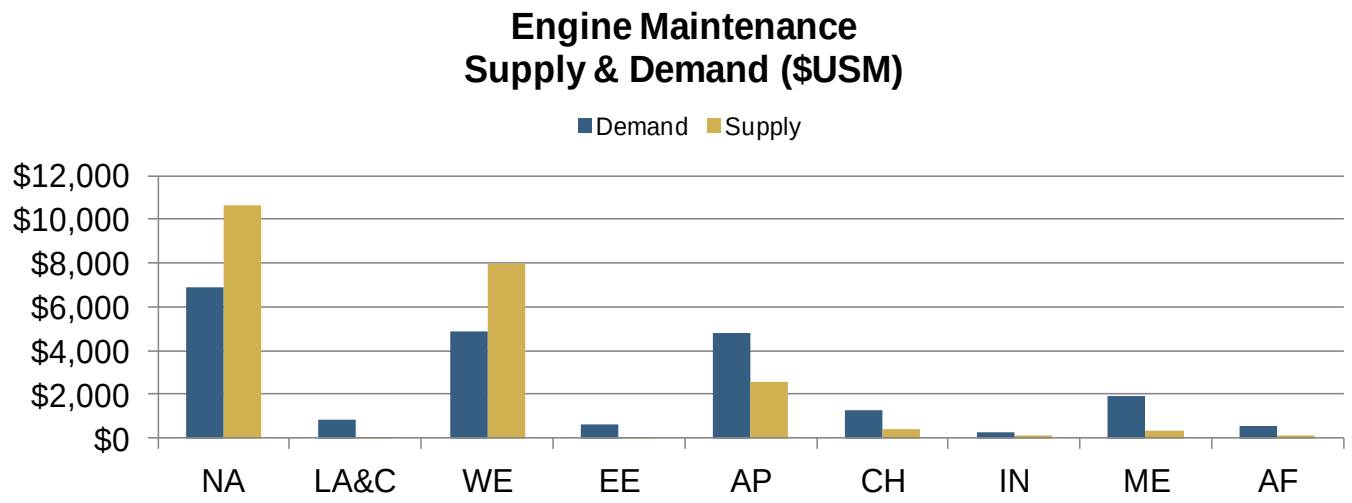
Table 9

met by engine MRO providers in India. Approximately $196M of this engine maintenance demand is performed in regions outside India. This results in $106M of engine maintenance supplied by Indian engine maintenance providers.

Middle East (ME) is a net importer of engine overhaul maintenance services. Middle Eastern operators generate $1.9B in engine overhaul demand. 15% of this demand is met by engine MRO providers in the Middle East. Approximately $1.6B of this engine maintenance demand is performed in regions outside the Middle East, and an additional $75M is conducted for other regions. This results in a total of $373M of engine maintenance supplied by Middle Eastern engine maintenance providers.

Africa (AF) is a net importer of engine overhaul maintenance services. African operators generate $579M in engine overhaul demand. 15% of this demand is met by engine MRO providers in Africa. Approximately $490M of this engine maintenance demand is performed in regions outside Africa, and an additional $5M is conducted for other regions. This results in a total of $94M of engine maintenance supplied by African engine maintenance providers.

2014 ENGINE MAINTENANCE BALANCE OF TRADE



Source: TeamSAI Consulting Services analysis

Figure 33

2014 ENGINE MAINTENANCE BALANCE OF TRADE: WHERE REGIONS HAVE MAINTENANCE PERFORMED

Region	Demand by Operator Region ($USM)	Supplier Region								
		NA	LA&C	WE	EE	AP	CH	IN	ME	AF
NA	$6,869	84%	0%	15%	0%	1%	0%	0%	0%	0%
LA&C	$835	69%	2%	28%	0%	1%	0%	0%	0%	1%
WE	$4,902	26%	0%	69%	0%	5%	0%	0%	0%	0%
EE	$614	18%	0%	77%	1%	5%	0%	0%	0%	0%
AP	$4,790	26%	0%	32%	0%	39%	2%	0%	0%	0%
CH	$1,306	41%	0%	34%	0%	6%	19%	0%	0%	0%
IN	$301	29%	0%	14%	0%	22%	0%	35%	0%	0%
ME	$1,947	46%	0%	29%	0%	10%	0%	0%	15%	0%
AF	$579	25%	0%	46%	0%	4%	0%	0%	10%	15%
Total	**$22,144**									

Source: TeamSAI Consulting Services analysis

Table 10

Component

Because global shipping enables the remote maintenance and overhaul of line replaceable units (LRUs) and rotable parts, component maintenance allows for significant inter-regional flow of trade. However, like the engine market, concentration of OEMs in developed regions (and their success at securing the aftermarket), drives a significant flow toward those regions. (See Figure 34 and Table 12.)

North American (NA) operators generate $4.3B in component maintenance demand. 70% of this demand is met by component MRO providers in North America. Approximately $1.3B of this component maintenance demand is performed in regions outside North America, and an additional $1.4B is conducted for other regions. This results in a total of $4.4B of component maintenance supplied by North American component maintenance providers. Thus, North America is a net exporter of component maintenance services.

Western Europe (WE) operators generate $2.6B in component maintenance demand. 82% of this demand is met by component MRO providers in Western Europe. Approximately $459M of this component maintenance demand is performed in regions outside Western Europe, and an additional $3.7B is conducted for other regions. This results in a total of $5.8B of component maintenance supplied by Western Europe component maintenance providers. Thus, Western Europe is a net exporter of component maintenance services.

Latin America, Eastern Europe, Asia Pacific, China, India, the Middle East, and Africa are net importers of component MRO services.

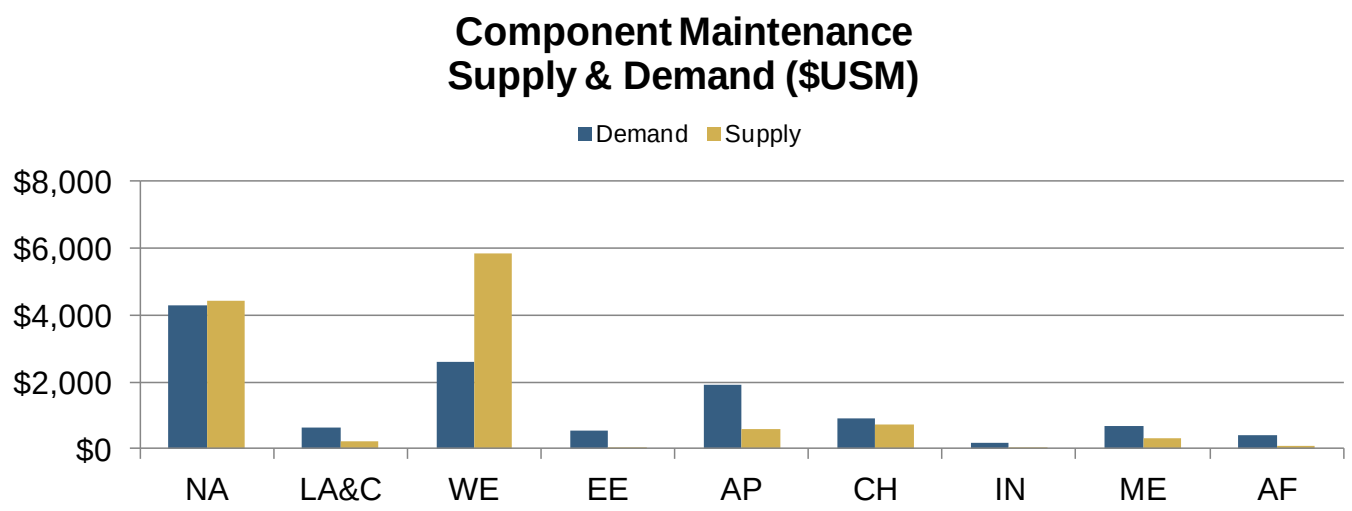
REGIONAL EX-/IMPORTER – COMPONENT

Region	Net Exporter/Importer
NA	net exporter
LA&C	net importer
WE	net exporter
EE	net importer
AP	net importer
CH	net importer
IN	net importer
ME	net importer
AF	net importer

Source: TeamSAI Consulting Services analysis

Table 11

2014 COMPONENT MAINTENANCE BALANCE OF TRADE



Source: TeamSAI Consulting Services analysis

Figure 34

2014 COMPONENT MAINTENANCE BALANCE OF TRADE: WHERE REGIONS HAVE MAINTENANCE PERFORMED

Region	Demand by Operator Region ($USM)	Supplier Region								
		NA	LA&C	WE	EE	AP	CH	IN	ME	AF
NA	$4,304	70%	2%	24%	0%	0%	0%	0%	4%	0%
LA&C	$650	42%	19%	39%	0%	0%	0%	0%	0%	0%
WE	$2,587	16%	0%	82%	0%	2%	0%	0%	0%	0%
EE	$560	4%	0%	94%	1%	1%	0%	0%	0%	0%
AP	$1,893	24%	0%	50%	0%	21%	5%	0%	0%	0%
CH	$921	17%	0%	2%	0%	11%	70%	0%	0%	0%
IN	$182	8%	0%	77%	0%	0%	0%	15%	0%	0%
ME	$664	6%	0%	78%	0%	1%	0%	0%	15%	0%
AF	$395	6%	0%	68%	0%	4%	0%	0%	5%	17%
Total	$12,156									

Source: TeamSAI Consulting Services analysis

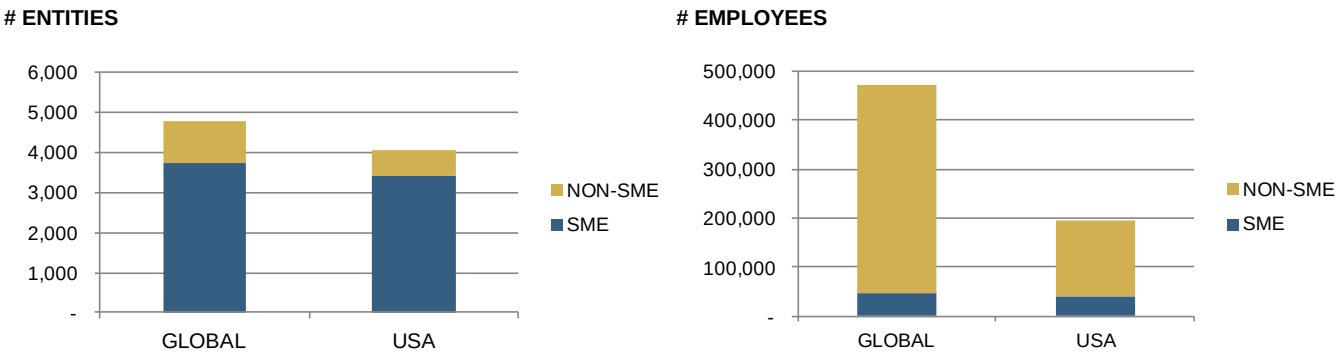
Table 12

AVIATION MAINTENANCE INDUSTRY EMPLOYMENT & ECONOMIC IMPACT

Global Civil Aviation MRO Employment

There are approximately 473,000 employees[13] from some 4,772 firms worldwide[14] participating in the civil MRO market. 78% of these firms are small/medium enterprises (SMEs[a]).[15] Globally, of the 281,859 technicians,[16] 22% are certificated.[17] In the U.S., there are an estimated 4,067 firms[18] with 195,114 employees[19] in the civil MRO market (excluding airline employees). SMEs comprise 84% of all firms[20] and account for 21% of all employees.[21] There are 143,843 technicians in the U.S.,[22] and approximately 37% are certificated.[23] (See Figure 35.)

2014 CIVIL AVIATION MRO ENTITIES AND EMPLOYMENT



Source: TeamSAI Consulting Services analysis

Figure 35

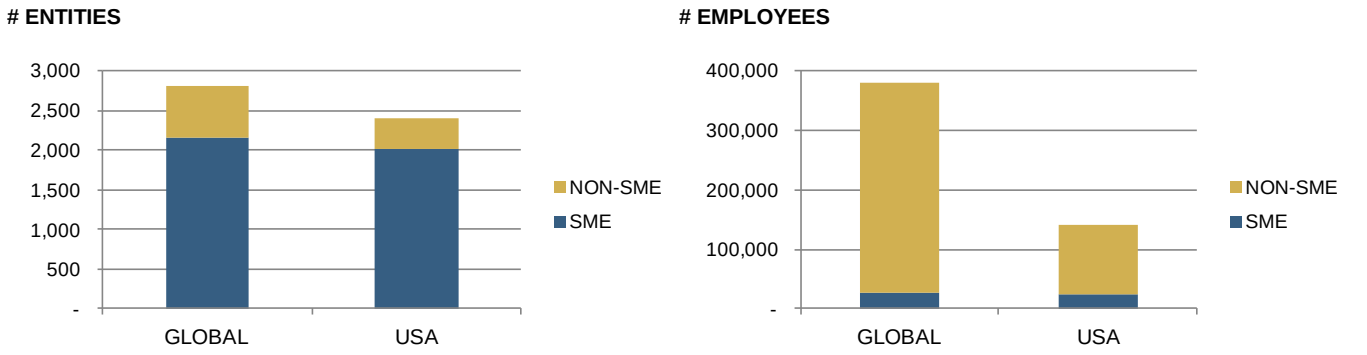
[a] For the purposes of this study, SMEs are defined to be firms with 50 or fewer employees.

Airframe

Heavy airframe maintenance facilities employ 379,331 employees[24] within 2,816 companies;[25] nearly 77% are SMEs,[26] which employ over 27,465 people worldwide.[27] In the U.S., there are 140,480 employees in the heavy airframe maintenance supply chain[28] within 2,403 companies;[29] nearly 84% of the providers in the U.S. are SMEs,[30] employing nearly 24,107 people.[31]

According to the FAA, there are 221,987 technicians engaged in heavy airframe maintenance,[32] with nearly 26% being FAA certificated individuals.[33] In the U.S., there are 103,387 technicians,[34] approximately 49% or 50,721 are FAA certificated.[35] (See Figure 36.)

2014 AIRFRAME MRO ENTITIES AND EMPLOYMENT



Source: TeamSAI Consulting Services analysis

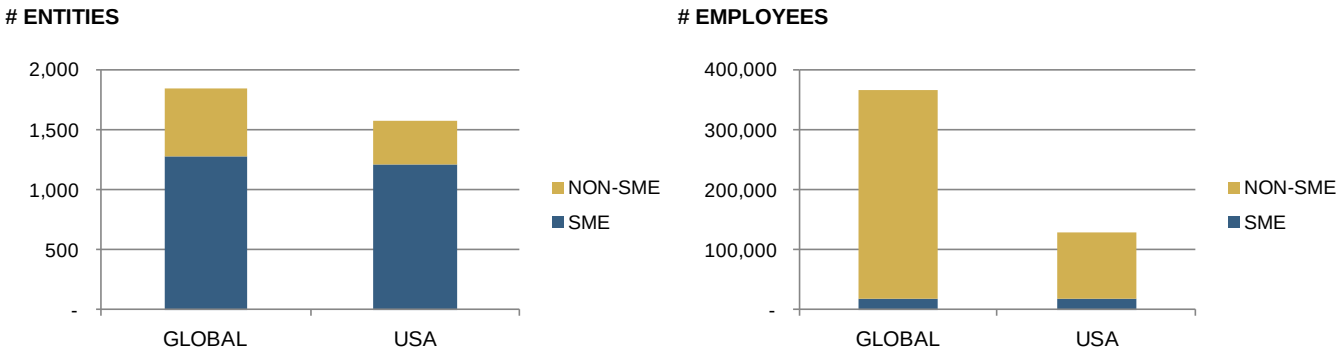
Figure 36

Engine

The global engine overhaul supply chain employs 366,241 employees[36] within 1,851 companies;[37] approximately 69% are SMEs,[38] employing nearly 19,248 people worldwide.[39] In the U.S., there are 129,773 employees in the engine overhaul supply chain[40] within 1,571 entities;[41] nearly 77.3%are SMEs[42] employing nearly 17,688 people.[43]

Globally, there are 212,665 technicians in the engine overhaul supply chain,[44] around 26% of which are FAA certificated.[45] In the U.S. there are 95,269 technicians,[46] approximately 50% or 47,771 are FAA certificated.[47] (See Figure 37.)

2014 ENGINE MRO ENTITIES AND EMPLOYMENT



Source: TeamSAI Consulting Services analysis

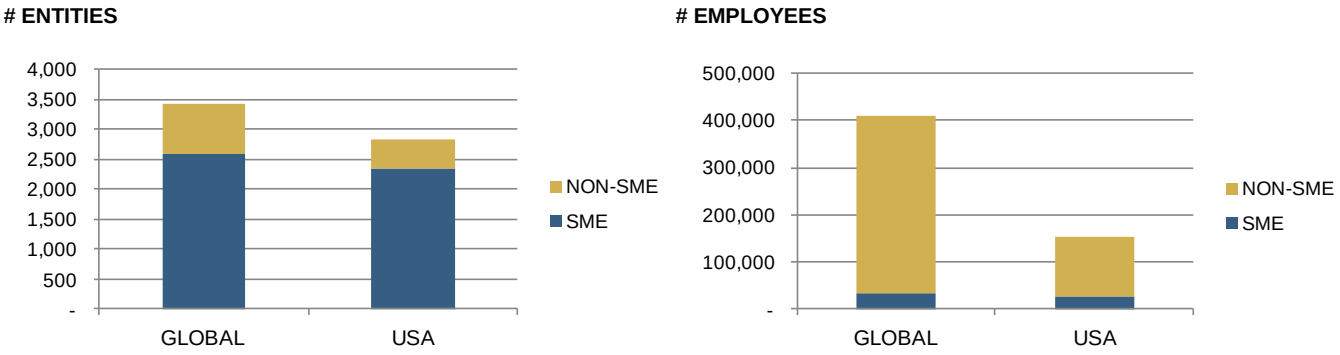
Figure 37

Component

The global component maintenance supply chain employs 411,360 employees[48] within 3,415 companies;[49] approximately 76% are SMEs,[50] employing nearly 33,498 people worldwide.[51] In the U.S., there are 154,552 employees[52] in the component maintenance supply chain within 2,836 entities;[53] about 83% are SMEs[54] employing 28,186 people.[55]

Globally, there are 241,337 technicians in the component maintenance supply chain;[56] around 23% are FAA certificated.[57] In the U.S. there are 113,799 technicians.[58] Approximately 41% or 47,144 are FAA certificated.[59] (See Figure 38.)

2014 COMPONENT MRO ENTITIES AND EMPLOYMENT



Source: TeamSAI Consulting Services analysis

Figure 38

Line

Labor, which is internal to the line maintenance facility, accounts for approximately 118,249 employees.[60] An additional 13,007 employees support work in other parts of the line maintenance supply chain.[61] In the U.S., it is estimated that approximately 49,030 employees are in the line maintenance supply chain.[62]

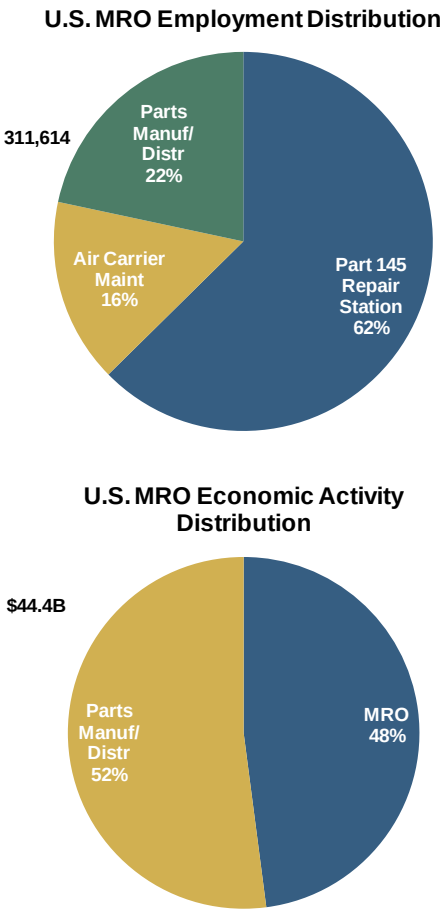
U.S. Employment & Economic Impact by State

The U.S. civil aviation maintenance industry employs over 311,614 people[63] and generates $44.4B in economic activity.[64] (See Figure 39.) MRO accounts for 78% of the total employment in the U.S.[65] with 244,144 employees.[66] Within the MRO industry, companies that are certificated by the FAA under part 145 are the largest employers with some 195,114 employees.[67] The remaining 49,030 are employed by other companies involved in civil aviation.[68] Parts manufacturing and distribution accounts for the remaining 22% of employment with 67,470 employees.[69] MRO generates 48% of the economic activity or $21.3B.[70] With 22% of the total employment,[71] parts manufacturing and distribution, accounts for 52% of the total economic activity or $23.1B.[72]

Analyzing the MRO industry at the state level, TeamSAI estimates that California, Florida, Georgia, and Texas combined[73] represent 35% of the total U.S. civil aviation maintenance employment[74] with an estimated 110,330 employees.[75] The top ten states represent 62% of the total employment in the U.S.[76] (See Figure 40.)

California and Texas also generate the most economic activity followed by Arizona, Connecticut, Georgia, and Washington.[77] Together, these six states generate 49% of the total economic activity.[78] (See Figure 41.)

2014 U.S. CIVIL MRO EMPLOYMENT & ECONOMIC ACTIVITY

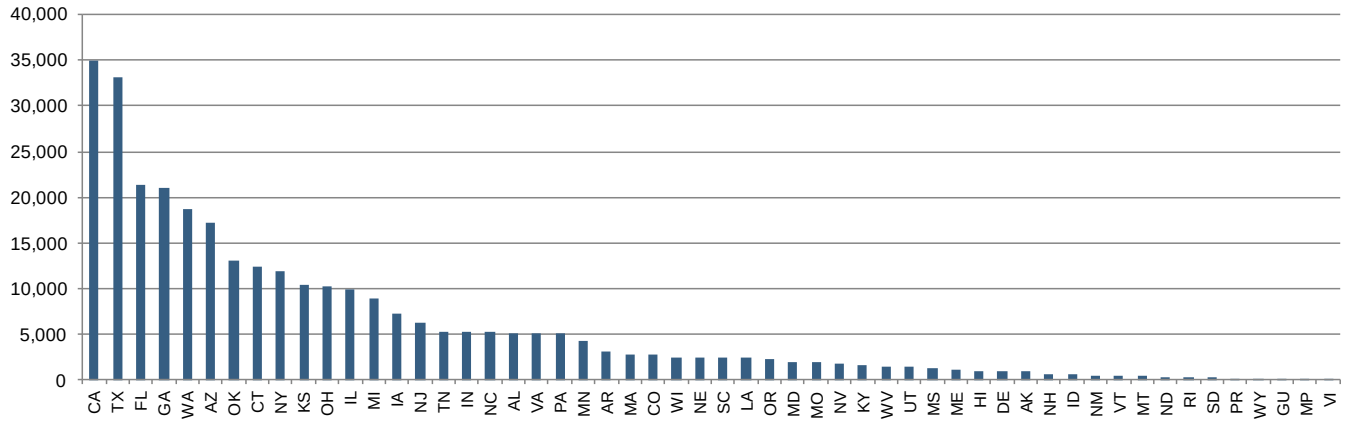


Source: TeamSAI Consulting Services analysis

Figure 39

2014 U.S. EMPLOYMENT RANKING BY STATE (# EMPLOYEES)

 # EMPLOYEES

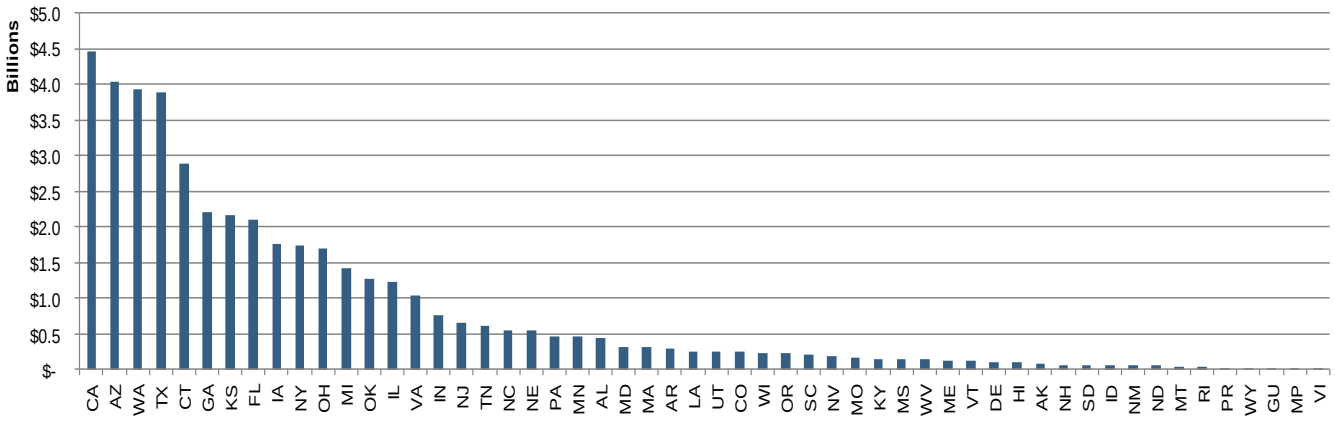


Source: TeamSAI Consulting Services analysis

Figure 40

2014 U.S. ECONOMIC ACTIVITY RANKING BY STATE ($USB)

ECONOMIC ACTIVITY



Source: TeamSAI Consulting Services analysis

Figure 41

2014 U.S. AVIATION MAINTENANCE INDUSTRY EMPLOYMENT AND ECONOMIC IMPACT

	Aviation Maintenance Industry Employement				Aviation Maintenance Industry Economic Activity		
	Maintenance, Repair and Overhaul (MRO)		Parts Manufacturing /Distribution	Total Employment	Maintenance, Repair and Overhaul (MRO)	Parts Manufacturing /Distribution	Total Economic Activity
State	FAA Repair Station	Air Carrier					
AK	490	417	9	916	$79,094,837	$3,084,064	$82,178,901
AL	5,065	-	28	5,093	$441,692,780	$9,594,866	$451,287,646
AR	2,927	79	61	3,067	$262,137,906	$20,903,101	$283,041,007
AZ	6,306	978	9,907	17,191	$635,200,436	$3,394,869,148	$4,030,069,584
CA	26,296	3,170	5,493	34,959	$2,569,579,358	$1,882,307,079	$4,451,886,437
CO	1,211	1,535	15	2,761	$239,464,634	$5,140,107	$244,604,741
CT	5,042	240	7,067	12,349	$460,616,241	$2,421,675,610	$2,882,291,851
DE	893	25	83	1,001	$80,054,091	$28,441,924	$108,496,015
FL	16,536	3,780	976	21,292	$1,771,654,593	$334,449,610	$2,106,104,203
GA	16,225	3,338	1,435	20,998	$1,705,989,309	$491,736,876	$2,197,726,185
GU	21	54	-	75	$6,540,367	$0	$6,540,367
HI	158	863	8	1,029	$89,036,195	$2,741,390	$91,777,585
IA	2,738	-	4,443	7,181	$238,766,995	$1,522,499,609	$1,761,266,604
ID	501	95	33	629	$51,974,116	$11,308,235	$63,282,351
IL	4,010	4,501	1,441	9,952	$742,200,839	$493,792,918	$1,235,993,757
IN	3,450	618	1,164	5,232	$354,749,502	$398,872,281	$753,621,783
KS	5,479	53	4,932	10,464	$482,417,465	$1,690,067,088	$2,172,484,552
KY	538	965	44	1,547	$131,068,953	$15,077,646	$146,146,600
LA	2,040	135	187	2,362	$189,670,641	$64,079,997	$253,750,638
MA	2,060	486	268	2,814	$222,023,656	$91,836,573	$313,860,229
MD	1,102	246	593	1,941	$117,552,195	$203,205,552	$320,757,747
ME	923	-	129	1,052	$80,490,116	$44,204,918	$124,695,033
MI	4,377	1,946	2,531	8,854	$551,396,534	$867,307,340	$1,418,703,874
MN	2,367	1,557	360	4,284	$342,191,998	$123,362,561	$465,554,559
MO	1,630	276	23	1,929	$166,212,525	$7,881,497	$174,094,022
MP	6	-	-	6	$523,229	$0	$523,229
MS	1,076	23	140	1,239	$95,838,177	$47,974,329	$143,812,506
MT	367	-	18	385	$32,004,195	$6,168,128	$38,172,324
NC	3,788	1,031	384	5,203	$420,240,376	$131,586,732	$551,827,108
ND	233	-	99	332	$20,318,740	$33,924,704	$54,243,444
NE	1,079	-	1,297	2,376	$94,094,079	$444,447,894	$538,541,973
NH	661	-	33	694	$57,642,434	$11,308,235	$68,950,669
NJ	4,060	1,735	449	6,244	$505,352,351	$153,860,528	$659,212,879
NM	462	-	47	509	$40,288,660	$16,105,668	$56,394,328
NV	545	1,175	116	1,836	$149,992,415	$39,750,159	$189,742,573
NY	5,761	3,438	2,743	11,942	$802,197,805	$939,954,181	$1,742,151,986
OH	6,052	937	3,174	10,163	$609,474,993	$1,087,646,581	$1,697,121,573
OK	12,188	335	523	13,046	$1,092,066,867	$179,218,387	$1,271,285,254
OR	1,645	552	116	2,313	$191,589,149	$39,750,159	$231,339,307
PA	3,411	1,536	114	5,061	$431,402,602	$39,064,811	$470,467,414
PR	116	55	-	171	$14,912,037	$0	$14,912,037
RI	251	-	44	295	$21,888,428	$15,077,646	$36,966,074
SC	2,197	164	10	2,371	$205,890,751	$3,426,738	$209,317,489
SD	83	-	170	253	$7,238,006	$58,254,543	$65,492,549
TN	2,633	2,055	601	5,289	$408,816,535	$205,946,942	$614,763,478
TX	21,871	7,300	3,910	33,081	$2,543,853,915	$1,339,854,483	$3,883,708,398
UT	342	697	458	1,497	$90,605,883	$156,944,592	$247,550,475
VA	1,179	1,557	2,336	5,072	$238,592,585	$800,485,952	$1,039,078,538
VI	2	-	-	2	$174,410	$0	$174,410
VT	171	-	297	468	$14,912,037	$101,774,113	$116,686,150
WA	8,838	888	9,012	18,738	$848,154,783	$3,088,176,114	$3,936,330,897
WI	2,155	195	94	2,444	$204,931,497	$32,211,335	$237,142,832
WV	1,483	-	38	1,521	$129,324,855	$13,021,604	$142,346,459
WY	74	-	17	91	$6,453,162	$5,825,454	$12,278,616
Total	**195,114**	**49,030**	**67,470**	**311,614**	**$21,290,551,239**	**$23,120,200,000**	**$44,410,751,239**

Source: TeamSAI Consulting Services analysis

Figure 42

CONCLUSION

This report detailed the air transport MRO market and the impact it has on economic activity. Moderately optimistic economic forecasts suggest an improved market environment for air transport, but concerns remain. Because maintenance is so closely tied to air transport, it is imperative MROs are aware of these outlooks and prepare accordingly.

MRO growth lies in the developing regions of Asia Pacific, China, and the Middle East, each of which stand to gain $4B or more in MRO value by 2024.

Globally, the fleet growth is solid; however, in the U.S., where fleet growth is flat, new deliveries largely will be used as replacement aircraft. Still, North America is a large market and will remain so, even as other regions grow their shares of the global fleet to comparable proportions. Developing regions in the Far East (e.g., China) are poised for substantial fleet growth. Asia as a whole is the engine of fleet growth, and in turn, the engine for MRO growth.

The aircraft of 1990's and 2000's vintage are expected to drive the increase in the market.

Globally, the air transport MRO market in 2014 is expected to be $57.7B in 2014 and to grow to $86.8B by 2024 (for jets and turboprops combined). This represents a healthy 4.2% CAGR. North America is the single largest region for MRO spend, driving $17.7B in 2014. This is forecast to grow very modestly though through 2024 by just 0.7% to $19.0B. Regionally, Asia Pacific, China, and the Middle East represent the greatest absolute net growth. Looking at the vintages expected to drive the most MRO growth by the end of the forecast, the 1990's and 2000's era aircraft dominate.

WHERE THE MRO GROWTH LIES ($USB)

Region	2014-24 Net MRO Increase
AP	$6.6
CH	$6.2
ME	$4.1
WE	$3.4
LA&C	$2.7
EE	$1.9
IN	$1.6
NA	$1.3
AF	$1.2
Total	**$29.2**

Vintage	2014-24 Net MRO Increase
1970's	-$1.2
1980's	-$8.7
1990's	$15.2
2000's	$15.9
2010's	$8.0
Total	**$29.2**

Source: TeamSAI Consulting Services analysis

Figure 43

Airframe MRO is forecast at $11.5B for 2014. Nearly 30% of this spend is for aircraft based in North America. Airlines themselves and their affiliated third party providers maintain a solid hold on this market. The airframe MRO market typically is considered a low-margin, labor intensive segment.

Engine MRO is expected to be $22.1B in 2014. More than 30% of this value is tied to North American operators. Unlike airframe MRO, engine MRO is largely contracted out and engine OEMs have a large share of this market. The engine MROs, recognizing the value of the aftermarket, typically enjoy higher margin work which is also more material intensive.

Component MRO is forecast to be $12.2B in 2014. Upwards of 35% of this spend is for North American aircraft. Like the engine MRO business, much of the component MRO market is contracted out, although it varies greatly from one component type to the next. Similarly, the labor/material mix can vary.

Finally, line maintenance is pegged at $11.9B in 2014. North America represents 27% of the market. The nature of line maintenance work makes it less prone to contracting; however, the potential to tap this market for line maintenance providers represents a significant opportunity in an otherwise slowly growing market. Of course, some of these opportunities may be limited to far flung airports. Because the work is labor-intensive, the opportunities to take advantage of economies of scale are constrained.

An examination of the regional balance of trade revealed that North America is a net importer of airframe maintenance but is a net exporter of engine MRO. Western Europe, as North America's largest peer, has a similar trend for engine work, although it is net exporter for airframe maintenance. Developing regions with low-cost but skilled labor tend to be net exporters of airframe maintenance. Regions with limited indigenous skills often must rely on other regions. Line maintenance does not allow for as much contracting.

In the U.S., nearly 4,100 firms with over 244,000 employees operate in the civil MRO market (including airline employees). Small and medium-sized enterprises (SME) account for 84% of these U.S. firms and 21% of all employees. There are over 143,000 technicians in the U.S. and approximately 37% are certificated.

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