GLOBAL FLEET AND MRO MARKET FORECAST 2022-2032

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FOREWORD

Oliver Wyman’s Global Fleet & MRO Market Forecast Commentary 2022–2032 marks our firm’s 22nd assessment of the 10-year outlook for the commercial airline transport fleet and the associated maintenance, repair, and overhaul (MRO) market. We’re proud to say that this annually produced research, along with our Airline Economic Analysis, has become a staple resource of executives working in aerospace manufacturing, airlines, MRO, and financing of the sector through private equity firms and investment banks.

The year’s research focuses on airline fleet recovery and growth in the wake of unprecedented challenges from the coronavirus pandemic as well as related trends affecting aftermarket demand, maintenance costs, technology, and labor supply. The outlook details how COVID-19 has significantly disrupted traffic, fleet dynamics, and MRO. Understanding these marketplace realities is vital to making well-informed business decisions and developing strategic long-term plans for the aviation industry.

As you will read in the report, the next few years are pivotal for industry recovery as COVID-19, economic forces, traveler sentiment, and government policies compel the industry to re-imagine its future.

In conjunction with each year’s Global Fleet & MRO Market Forecast, we conduct an annual survey on hot topics, critical issues, and new opportunities in MRO. To participate in the 2022 survey, please contact the research team at MROsurvey@oliverwyman.com.

Oliver Wyman’s Aviation Competitive and Market Intelligence team, partners, and vice presidents are available to assist with any questions about this forecast, as well as with the Airline Economic Analysis, which is scheduled to be released in March. We hope you find the data and insights valuable as you refine your business models and develop strategies for moving forward.

Best regards and wishes for a wonderful 2022,

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Partner and Study Leader
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A DECADE OF GROWTH, WITH A FEW CAVEATS

After two years of turmoil, the aviation industry appears to be poised for a decade of growth. But unlike the last decade, which enjoyed steady annual increases in demand, the next 10 years are apt to be filled with a multitude of challenges that will test the industry's resilience.

COVID-19 continues to torment airlines and aerospace as well as the global economy in general despite effective vaccines. While a significant portion of domestic air travel demand around the world has recovered and the fleet is growing again, the unpredictable nature of COVID-19 and its variants remains the industry's biggest immediate obstacle to business as usual. The rapid spread of Omicron at the end of 2021 set in motion a variety of complications for the industry from absenteeism in the workforce, to government travel restrictions, to disruption of the supply chain, to name a few.

Even so, as we enter 2022, there is cautious optimism that the industry has turned the corner and is once again on an upward trajectory, thanks to widespread dissemination of vaccines, government stimulus, and pent-up demand for travel — at least in developed economies. By the early part of 2023, global demand for domestic travel is expected to reach and exceed its 2019 pre-pandemic peak. From there, the outlook is for steady growth through the rest of the decade at rates that even exceed expansions in gross domestic product.

Worldwide, the business and international travel segments, on the other hand, will take longer to recover, restricted by corporate and government policies unlikely to be fully lifted until COVID-19 transitions into an endemic disease. But it was not just restrictions that took a bite out of corporate travel.

Videoconferencing and a mounting recognition that people can conduct business without being face to face has had an impact. In the foreseeable future, sluggish business travel recovery is apt to put a cap on both airline profitability and growth, but the potential for lower long-term corporate demand exists.

For international travel, the biggest impediment has been and will be the disparity between cross-border rules and vaccination coverage. Globally, a slow recovery in this segment will limit the number of widebody aircraft in the fleet for years.

At the beginning of 2022, the global fleet was the same size as it was in 2017, and it is not expected to top its January 2020 apex of almost 28,000 until sometime in the first half of 2023. By 2032, the fleet is expected to eclipse 38,100 aircraft, a compound annual growth rate (CAGR) of 4.1% between January 2022 and the beginning of 2032.
Because of the slower return of international travel, most of the fleet recovery will be in narrowbody aircraft, which will make up about 64% of the fleet by 2032 versus 58% in January 2020. While narrowbodies are expected to recover to pre-pandemic levels by midyear, much of the increase initially will be from aircraft being brought out of storage or the delivery of aircraft in manufacturers' inventory. Before COVID-19 struck, the industry was struggling with the 2019 worldwide grounding of the 737 MAX — more than 400 of which had been built but not delivered at the time the pandemic shut down air travel in 2020.

While most of the fleet is a story of recovery, cargo is a story of growth. A 17% increase in shipments in 2021 over 2019 — thanks in part to COVID-related online shopping — pushed the cargo fleet to expand during the pandemic. In 2021, the number of aircraft dedicated to cargo grew 3%, and the conversion of passenger aircraft to freight use broke records.

For the maintenance, repair, and overhaul (MRO) sector, the market is being redefined by a fleet in transition, in part because of higher numbers of retirements of aircraft due to enter a period of intensive MRO expenses. MRO demand should recover to pre-COVID levels by 2024, but annual growth in the second half of our 10-year forecast period will be 2.8%. By 2030, MRO demand is expected to reach $118 billion, 13% below the pre-COVID forecast of $135 billion.

The slower growth projections won't apply everywhere around the world. For instance, the active China-based fleet and its MRO demand had already exceeded pre-pandemic levels by the end of 2021. Other regions like Western Europe will not see MRO demand recover until 2025.

Another trend that will reshape the MRO landscape is a potential push toward onshoring of capacity — a direct response to the impact of COVID-19's unforeseen stranding of some assets with quarantines and its continuing disruption of supply chains. While some of the impetus is expected to diminish as COVID-19 fades, airlines and aerospace manufacturers are likely to want a decent amount of capacity that cannot be taken out of the mix by trade wars or sudden travel restrictions. That translates to domestic maintenance providers.

Beyond COVID-19, there are additional impending risks on the horizon that portend some degree of disruption for the industry.

The first is a labor force potentially too small to support aviation's anticipated growth. Prior to the pandemic, the industry was already looking at a potential shortfall mid-decade in the number of key aviation workers — pilots and aviation mechanics chief among them. At the time, the pressing problem was baby boomers reaching retirement age and not enough candidates to take their place. The pandemic has exacerbated those demographic trends by encouraging early retirements among airline and aerospace workers uncertain about the career prospects in a sector that COVID-19 almost entirely shut down for months.

Likewise, two years of pandemic also is likely to have discouraged many would-be pilots and mechanics from entering the industry. With demand lagging, the industry hasn't had to fully confront the problem yet, but that won't be the case for much longer. Over the next 20 years, Boeing estimates, the industry will need 612,000 new pilots, 626,000 new maintenance technicians, and 886,000 new cabin crew members.
Another challenge facing the industry is climate change. Currently, aviation accounts for about 2.3% of total carbon dioxide emissions — still dwarfed, for instance, by road transport and other economic activities. But the anticipated transition to electric vehicles over the next 10 years is likely to cut road transport’s share of total emissions from transportation and potentially raise aviation’s — an industry without an immediate alternative to fossil fuels. That may increase pressure on the industry and even result in efforts to limit commercial flying.

Despite the fact that aerospace manufacturers have been relentlessly driving for more fuel efficiency almost since the industry’s inception, there is no existing or obvious technological solution for substantially cutting emissions — at least not over the next decade. While research and development are underway on the use of hydrogen or electric engines to power aircraft, the commercial production of such revolutionary aircraft for commercial flight is probably 15 to 20 years off.

Since the potential for more efficiency gains on traditional jet engines appears somewhat limited, the most effective tool immediately available is sustainable aviation fuel (SAF), made from non-fossil feedstocks such as used cooking oil and waste animal fat. While SAF can produce 80% fewer emissions than conventional jet kerosene-based fuels like Jet-A1, currently less than 1% of the fuel consumed by aviation is SAF. Most of the biggest airlines have pledged to increase that percentage to 10% by 2030, but even if sufficient capacity was built in time to produce the necessary SAF, that percentage would still not fully offset the anticipated expansion in air travel. A fuel mix of at least 15% SAF by 2030 would be needed to just keep the industry at its 2019 level of carbon dioxide emissions — far from the halving of global emissions called for at the recent COP26 climate conference in Glasgow, Scotland.

The other problem is SAF’s economics: SAF is three times more expensive than conventional jet fuel for airlines and yet less profitable to produce than the renewable diesel used for road transport and ships. That makes it unattractive to both users and producers. Only substantial government subsidies or tax incentives could level the playing field to encourage sufficient airline consumption, investment in SAF production, and ultimately a reduction in the price difference with conventional fuel.

As unimaginably bad as COVID-19 has been for aviation, the next challenge may prove almost as disruptive unless smart strategies are employed today to better position the industry for the 2030s. While aviation is almost guaranteed to keep expanding over the next decade, its ability to carve out profits and remain sustainable will be much more uncertain, given these challenges.
# FLEET AND MRO FORECAST SUMMARY

## 2022 Fleet

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<thead>
<tr>
<th>Region</th>
<th>Africa</th>
<th>Middle East</th>
<th>Asia Pacific</th>
<th>China</th>
<th>India</th>
<th>Latin America</th>
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## 2032 Fleet

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## Fleet growth rates

- **2020–2026**: 1.1% 3.5% 1.7% 4.5% 9.7% 0.7% 1.2% 5.1% -0.3% 2.0%
- **2026–2032**: 1.5% 5.6% 3.6% 6.3% 5.4% 1.8% 1.7% 5.9% 1.4% 3.3%
- **2020–2032**: 1.3% 4.5% 2.6% 5.4% 7.5% 1.3% 1.4% 5.5% 0.6% 2.7%

## 2022 MRO (US$ in billions)

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## 2032 MRO (US$ in billions)

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## MRO growth rates

- **2019–2026**: 0.5% 0.8% 2.8% 9.0% 5.2% -1.1% 2.2% 4.2% -0.1% 2.4%
- **2026–2032**: 1.5% 6.0% 3.0% 3.4% 10.9% 2.4% 0.8% 4.6% 0.9% 2.8%
- **2019–2032**: 0.9% 3.2% 2.9% 6.4% 7.8% 0.5% 1.5% 4.4% 0.4% 2.6%
GET INTERACTIVE WITH THE FORECAST DASHBOARD

To enhance the *Global Fleet & MRO Market Forecast 2022–2032*, we have created an interactive dashboard that lets users explore online the results of the forecast in a deeper fashion. Employing a filter of their choice, readers can view the data from Oliver Wyman’s forecast in the ways most relevant to them.

The dashboard is made up of two views. The first is a summary view that looks at the size, growth, and share of the global maintenance, repair, and overhaul (MRO) market. With the ability to filter by aircraft class and specific MRO segments, users can identify changing trends and the relative size of MRO demand by market.

The second view provides more granular insight into the size of the MRO market by year and growth by geographical region. A breakdown of fleet growth in terms of deliveries, retirements, and removals from storage is also provided. By filtering for region or MRO segment, users can identify growth trends and potential vulnerabilities for various geographies and sectors.

This dashboard highlights the strength and flexibility of the Oliver Wyman Global Fleet & MRO Forecast models. For questions on the report or how to get the most out of the dashboard, please reach out to AviationMarketIntelligence@oliverywyman.com.

To view the Fleet & MRO Forecast Interactive Dashboard, please click here
STATE OF
THE INDUSTRY
FROM PANDEMIC TO ENDEMIC

As the world enters its third year of the COVID-19 pandemic, the aviation industry is doing better than it has at any point since the pandemic began. Air travel and the global commercial fleet are inching their way back to pre-pandemic levels after the worst downturn in aviation’s history. While international and business segments have not yet recovered to the same degree, overall domestic demand worldwide is expected to surpass pre-pandemic levels in the early part of 2023 and airlines are preparing for long-term capacity growth.

Nonetheless, for commercial aviation, the disruption and the losses from the pandemic are not entirely over yet. By the end of last year, airlines worldwide had lost $190 billion as the pandemic demolished what seemed to be a predictable industry growth pattern. Many carriers will still be in the red again in 2022, with losses for the year expected to exceed $11.6 billion, according to the International Air Transport Association (IATA).

If 2020 should be characterized as a year of unprecedented turmoil and downturn across aviation, then 2021 could be seen as a year when the industry began a slow and sometimes bumpy recovery. Since the spring of 2021, as vaccines were more widely distributed and new case counts started to drop, pent-up demand for domestic air travel began to drive growth in most countries. Still, regional recovery rates differed significantly, depending upon epidemiological factors, government policies, economic stability, and passenger sentiment.

With the appearance of highly contagious new variants in the summer of 2021, medical experts increasingly talked about the possibility that COVID-19 would be with the world for a while — becoming more endemic like influenza than pandemic. But the short-term implications of COVID-19 for aviation are still somewhat unclear.

GOVERNMENT IMPACT

Over the past two years, it has become evident that government policy and intervention have had the most substantial impact on passenger demand and industry recovery, at moments simultaneously helping and hurting the outlook. Economically, significant stimulus support, especially in the United States and Europe, allowed airlines to keep much of their workforces employed during the months when there was very little travel. It also fueled an economic rebound in most regions that contributed to the demand recovery.

But mandatory quarantine periods, domestic and international restrictions limiting travel between certain countries, and strict testing requirements for travelers all directly or indirectly have suppressed passenger traffic.
With the dawn of 2022, the underlying drivers for passenger demand are shifting from case-driven scenarios to manageable healthcare outcomes — particularly as variants differing in transmissibility and severity emerge. Public policy should continue to evolve accordingly, supporting industry recovery.

**CARGO'S GOOD NEWS**

The one consistent bright spot for the industry throughout the pandemic was the growth in cargo, which helped offset at least a portion of losses elsewhere for many airlines. Dedicated cargo fleet growth of over 3% in 2021 was fueled by a jump in online shopping as COVID-19 prompted an acceleration in e-commerce among consumers.

Putting additional pressure on capacity, there was also a decline in available belly cargo space as significantly fewer widebodies were being flown globally. The rising demand and limited capacity resulted in a record number of passenger-to-freighter (P2F) conversions.

The conditions also pushed up shipping rates to record highs toward the end of 2021, as the rise in cargo volume and COVID-related employee absenteeism in the shipping industry put a strain on global supply chains. By December 2021, prices on Asia-to-North America cargo routes had jumped 75% against August rates as companies endeavored to fulfill orders before Christmas.

**THE GROWTH OF GDP MATTERS**

While demand for air travel has historically been closely tied to GDP trends for most of the past 50 years, growth in passenger traffic during the decade ending January 2020 outpaced global economic expansion. From 2015 through 2019, this growth helped airlines record strong profits and boosted demand for new aircraft to all-time highs. By January 2020, the global in-service commercial fleet was at its largest to date — almost 28,000 strong.

In 2019, air transportation — with $876 billion in revenue — represented 1% of global GDP, according to International Air Transport Association (IATA). But the industry’s historical share dropped dramatically over the past two years, and it is expected to take several years before it can be recouped.
Exhibit 1: 20-year projections for gross domestic product and traffic growth, 2020–2040

In the five years before COVID-19, an expanding middle class in countries such as China and India and a proliferation of low-cost airlines fueled industry growth. Despite the somewhat uneven recovery since the COVID-19 lockdowns, these longer term economic and market forces will still be at play moving forward. China and India are seeing two of the strongest economic rebounds worldwide. This will lead to growth in passenger demand and fleet size over the next decade in these regions as will low-cost airlines because of the value proposition for consumers.
STABILIZING LOSSES

The catastrophic financial impacts of COVID-19 for 2020 turned out to be even worse than first suspected. According to IATA, annual airline losses in 2020 totaled $137.7 billion, 9% larger than the $126.4 billion projected earlier in 2021 and 16% higher than the $118.5 billion projected at the end of 2020. As pockets of demand began to recover last year, these losses partially stabilized, with a global net loss of $51.8 billion expected for 2021. Even so, the $26 billion in 2019 airline profits is unlikely to be realized again for many years. Short-term margins are expected to remain in the red, with global losses of $11.6 billion forecast for 2022 as revenue recovery lags growth in operational expense headwinds.

Exhibit 2: Global airline industry financial performance, 2012–2022F

The financial position of airlines differs significantly by region, with the outlook for North American carriers the most positive. According to IATA projections, airlines in North America will report profits again in 2022. The forecast, as of October 2021, is $9.9 billion — just 55% of the 2019 figure. While North American airlines incurred net losses in 2021, U.S carriers were showing improved financial strength by the end of the year, with the four largest airlines — Delta Air Lines, Southwest Airlines, American Airlines and United Airlines — all reporting net profit in the third quarter.
In Europe, net losses are expected to continue in 2022, with IATA projecting a loss of $9.2 billion — the most of any region. While the intra-Europe market will provide some top-line strength, the continued weakness in inter-regional traffic will hurt the overall performance of carriers.

Because of the multiyear hit from COVID, governments worldwide have provided financial support to carriers via wage subsidies, direct aid, tax deferrals, and loans. Through September 2021, government aid during COVID-19 totaled $243 billion, according to IATA.

**CLIMATE CHALLENGES**

As aviation continues to deal with COVID-19, the industry will also have to begin to tackle the challenge of reducing greenhouse gas emissions. And in this arena, pressure is building on all industries to produce some real results.

In November 2021, global leaders from nearly 200 nations convened a climate summit in Glasgow, Scotland, to discuss ways to accelerate and amplify efforts to combat climate change. The primary goals were to eliminate half of the world's greenhouse gas emissions by 2030 and getting to net-zero emissions by 2050.
In aviation, 25 countries signed the International Aviation Climate Ambition Declaration, which commits to working with the International Civil Aviation Organization (ICAO) to advance emissions reduction. Those pledges include:

- developing and deploying more low-carbon sustainable aviation fuel (SAF),
- advancing no- or low-carbon aircraft technology innovation, and
- ensuring the maximum effectiveness of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) — a global agreement among nations that CO2 emissions from international air travel that exceed 2020 levels will be offset by airlines.

While aerospace manufacturers have always innovated with new technology, the emissions reduction challenge for aviation may at first seem more formidable than for many other industries — primarily because of the most hopeful low-carbon propulsion systems in development won't be commercially available until at least 2035.

At present, aviation's best alternative is SAF, a biofuel made primarily from used cooking oils and waste animal fats. Compared with conventional jet fuels, SAF is estimated to reduce carbon emissions by 80%, so it could help the industry make progress toward meeting reduction goals. But while the science is there, the economics are not.

First, SAF is currently three times more expensive than commercial-grade jet fuel — a stumbling block for airlines already seeing their revenue and operating profits slashed by COVID-19. While it will compose only a relatively small share of the industry's total fuel consumption for the foreseeable future — somewhere between the less than 1% currently consumed and the 10% goal for 2030 — the extra cost is yet another pressure on the industry. To accommodate it, one of three scenarios would have to come true — or a combination of the three:

1. Consumers would have to be willing to pay premiums for SAF-powered flights.
2. Government subsidies would have to be provided to cover the additional cost.
3. The economics of producing SAF would have to improve enough to drive down the price and increase the product’s profitability.

Not only is SAF more expensive to buy, it’s also more expensive than many other biofuels to make — and less profitable for producers. SAF and renewable diesel (RD) use the same refinery capacity as well as the same feedstock, but right now the market's focus has been on RD because it’s cheaper to produce and more lucrative to sell, thanks to more generous government incentives. RD also benefits from a bigger, more diverse marketplace as it’s used in trucks, boats, farm equipment, off-road vehicles, and more. While much of the RD capacity could be converted to SAF production at some point, those investment decisions probably won't be made without more of a guarantee that there's a profit to be made in SAF. That would require more subsidies like RD and long-term purchasing agreements with airlines.
Meanwhile, in the fall of 2021, over 50 of the biggest airlines and energy companies committed to expanding SAF usage and production. The group agreed to adopt a goal of 10% SAF in the aviation fuel mix by 2030. But there are two problems with that target: The first is that there is not enough actual or planned SAF capacity for airlines to increase to 10% usage. Second, 10% SAF would not even be enough to limit emissions to 2019 pre-pandemic levels. That would require at least 15%.

On the technology front, aerospace manufacturers continue to push forward on fuel efficiency as they have been for the past half-century. At the end of 2021, Pratt & Whitney introduced the GTF Advantage engine, an upgraded version of the PW1100G. Scheduled to be the production standard for all A320neo aircraft starting in 2024, this engine will reduce fuel burn by an additional 1% compared with the current engine on the aircraft.

This is important progress, given that the A320neo is expected to be the most delivered aircraft platform over the next decade. These engines will also be compatible with 100% SAF, an increase from the 50% that the current versions are certified to use.

Exhibit 4: Various scenarios of anticipated CO₂ emissions from commercial aviation

<table>
<thead>
<tr>
<th>Emission output scenarios</th>
<th>Scenario likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current-gen aircraft (NG/ceo) and new technology (LEAP/GTF) adopted and no aircraft replaced</td>
<td></td>
</tr>
<tr>
<td>New-gen technology adopted in line with forecast expectations. Current SAF supply and usage throughout decade; penetration rate stays below 1%</td>
<td></td>
</tr>
<tr>
<td>SAF penetration rate reaches 15% of global fuel consumption by 2030; slight operational improvements to fuel burn per hour in developed regions</td>
<td></td>
</tr>
<tr>
<td>SAF penetration rate reaches 20% of global fuel consumption by 2030; slight operational improvements to fuel burn per hour in developed regions</td>
<td></td>
</tr>
</tbody>
</table>

Source: Oliver Wyman analysis
But again, this effort to incorporate SAF is an incremental fix when it comes to the ambitious emissions reduction goals the global economy must fulfill. Entirely new technology will be needed that no longer relies on fossil fuels.

Both startups and traditional original equipment manufacturers (OEMs) are racing ahead with design concepts for alternate propulsion systems — powered by electric, hybrid electric, and hydrogen. While experimental aircraft are being flown now using these new technologies, none have been able to fulfill the power requirements for commercial airliners.

In the case of electric, batteries have not been developed that provide enough power without being too heavy to fly. In the case of hydrogen fuel, there is an array of technological hurdles that engineers still must scale as well as insufficient renewable energy capacity worldwide to produce the so-called green hydrogen necessary to eliminate emissions. Given the product and development cycle of aviation technology, these new propulsion systems are unlikely to make it into production for commercial airliners until 2035 or later.

**TRAFFIC AND GLOBAL DEMAND GROWTH**

After COVID-19 was declared a pandemic in March 2020, passenger traffic was decimated by a combination of business closures, an economic downturn, almost no business travel, and a public afraid to fly. But domestic demand began to return toward the end of 2020 as the global economy started to function again. Then growth took off in the spring of 2021 with the arrival of the vaccines. International travel, on the other hand, remained depressed in 2020 and for most of 2021, with government restrictions and quarantine requirements for cross-border travel putting a damper on any demand that existed.

Global passenger demand in 2021, as measured by revenue passenger kilometers (RPKs), grew 18% year-over-year, but for the full year, it was still at 60% of 2019 levels. Capacity, as measured by available seat kilometers (ASKs), remained similarly depressed, with full-year 2021 figures at 50% of 2019 levels, according to IATA.

In 2020, load factors slid to 65.1% from 82.6% in 2019, and 2021 showed only a slight improvement to 67.1%. That's because a volatile recovery made it tricky for airlines to match their capacity to passenger demand and forced many to bring aircraft out of storage before demand had fully materialized. In 2022, passenger load factors are expected to increase eight percentage points to 75.1% as RPKs recover.
CARGO BOOM

On the cargo side, demand as measured by cargo tonne kilometers (CTKs) increased 18% in 2021 — eclipsing 2019 levels — while capacity as measured by available cargo tonne kilometers (ACTKs) increased 16%. Historically, passenger and cargo demand have grown in tandem with economic expansion. But this pattern was disrupted in 2019 when CTKs declined, even as passenger travel inched up. This partly reflected mounting trade tensions, particularly between the US and China.

The drop in CTKs was also a byproduct of the decline in heavier traditional cargo shipments while e-commerce deliveries rose. E-commerce cargo requires significantly more space because of its volume, but it is generally lighter and less dense. This shifting cargo profile, combined with other factors, helped drive a 5% expansion in the global cargo fleet in 2019 even as CTKs decreased.

In 2020 and 2021, CTKs were on the rise again as e-commerce shipments grew quickly because of the COVID-19 pandemic, which pushed people to buy goods online. Passenger-to-freighter conversions (P2F) reached record highs in 2021 as cargo operators tried to add capacity to meet surging demand. But even with the conversions, growth is somewhat limited by a lack of capacity.

Looking ahead, we expect to see even more conversions, given an increase in the supply of attractive P2F aircraft candidates and continued cargo demand growth, which makes investment in conversion capacity attractive.
OEMs also recognize opportunities in cargo aircraft. In 2021, Airbus announced a freighter version of the A350, dubbed the A350-950F, with Air Lease as the launch customer. In January 2022, Boeing announced plans to make a cargo version of the 777X with Qatar Airways placing an order for 34 777-8Fs. Because of ICAO noise and emission regulations, Boeing won’t be able to continue production of the 767 and 777-200ERF freighters, as currently constructed, after 2027.

Turboprop manufacturers are also entering the cargo market, with the delivery of the ATR72F in 2020 and deliveries of the SkyCourier to FedEx starting in February 2022. This flurry of new aircraft indicates manufacturers view this market as a beneficial investment.

**REGIONAL RECOVERIES**

Just as the pandemic and strategies to combat it have played out differently among countries, so too has the aviation recovery in various nations. Some domestic markets, like China’s, have already returned to 2019 demand levels, while others, like Malaysia’s, are still significantly below pre-pandemic peaks. Across almost all regions, international demand remains depressed, stifled by travel restrictions and changing health protocols for passengers.
Exhibit 7: US COVID-19 cases and demand

In June 2021, the Delta variant — first identified in India in December 2020 — spread rapidly through the United Kingdom and then the US before becoming the dominant strain worldwide in late summer. A small percentage of breakthrough infections in the vaccinated population were identified, and the combined impact led to a slowdown in global domestic travel recovery. In the second half of the summer, domestic RPKs began to drop: In July 2021, they were at 84% of July 2019 levels; by August, they dropped to only 68% of August 2019 levels, according to IATA. Much of the decline was driven by a 57% drop in China brought on by the Delta outbreaks and August lockdowns.

Still, in places like the US — despite new case counts that exceeded earlier peaks — there was only a minimal dip in air travel demand accountable to COVID. Traffic at America’s airports after the summer peak was only marginally lower, according to Transportation Security Administration data; Oliver Wyman estimates the volume reduction from August to September caused by the Delta variant was just 3%.

International travel lanes also began to see activity rise in the fall of 2021. The US lifted travel restrictions to Europe for vaccinated passengers in early November. But the good news was short-lived. In late November, the Omicron variant emerged in South Africa, and governments around the world reimposed travel restrictions.

Despite the transmissibility of Omicron — which generated a much larger number of breakthrough cases among the vaccinated than Delta — it has proven so far to be less severe. For example, in the US, traveler enthusiasm seemed relatively intact, and both Thanksgiving and Christmas seasons saw strong numbers — close to 90% of 2019 levels.
Instead, the primary deterrents to travel to this point — particularly in regions with high vaccination rates — appear to be government restrictions and containment strategies. Strict testing requirements in order to fly and quarantine measures upon arrival have been shown to suppress demand, and travel restrictions for both international and domestic travel directly reduce traffic. According to IATA, the reinforced domestic travel restrictions in Japan and Australia throughout August resulted in seasonally adjusted RPKs declining month-over-month by 15.3% in Japan and 8.9% in Australia.

Another factor affecting recovery is the long-term outlook for business travel. Specifically, one of the biggest variables is the possibility that telecommuting and videoconferencing may permanently cut into the need for business trips, which generally provide operators higher yields.

As for economic recovery, many countries have seen continued momentum since the recessionary impact of COVID-19. While a high level of uncertainty exists — particularly as variants emerge — the IMF estimates global economic growth at 5.9% for 2021 and 4.4% for 2022.

While these factors ultimately drive the speed of recovery, the effects of COVID-19 will linger even after passenger demand fully rebounds. COVID-19 has set back industry growth forecasts by at least two to three years, with pre-pandemic forecasts for passenger demand for 2030 not expected to be reached until 2032 or 2033. In short, there will be lost growth that is unlikely to ever be completely recouped.

Globally, Oliver Wyman expects total passenger demand to reach 2019 levels by mid-2023, with a compound annual growth rate (CAGR) of 3.8% through 2030. As with economic projections, there is uncertainty on outlooks for recovery in passenger demand. In a prolonged scenario, recovery may not be achieved until late 2024, while a more accelerated scenario foresees a strong rebound by the end of 2022.

With different vaccination rates among nations, government restrictions, and macroeconomic impacts, the recovery in passenger demand will vary by region and travel segment. Domestic traffic, as measured by passenger count, exceeded 2019 levels toward the end of 2021 in some countries, including Russia and China. Outside of China and Eastern Europe, North America is expected to bounce back the fastest, with total passengers, including international travelers, reaching 2019 levels in 2023. Domestically, travel in the US is expected to see full recovery by mid-2022.

Recovery in Asia Pacific lagged behind the rest of the world in 2021. With the exception of Vietnam, domestic passenger traffic in most of the region stalled throughout the year and is not expected to reach 2019 levels until early 2023. At the end of 2021, Asia Pacific’s active fleet was at almost 80% of pre-COVID levels. The delayed recovery reflects the region’s dependence on international travel and many Asian nations’ strict travel rules. International demand in the region is not expected to recover until 2024.

Even with rapid spread of the Delta variant, Western Europe saw a fairly strong recovery throughout the summer as well as strong growth in the number of active aircraft. The region’s fleet expanded 28% in 2021 from an admittedly low base in 2020. Domestic travel is expected to recover in early 2023, with the international segment by mid-2024.
In addition to COVID-19, Western European air travel is more vulnerable than other regions to the impact of concerns over aviation's greenhouse gas emissions based on public sentiment in Europe.

When full recovery is attained, the global industry landscape will have changed, perhaps significantly, with several dozen carriers no longer flying. Over 60 airline failures or restructurings are estimated to have occurred in 2020, and the data analytical firm, IBA, estimates an additional 20 airlines will fail over the course of 2022.

**FUEL AND LABOR**

In the typical year, the purchase of jet fuel represents about one-quarter of operating expenses. As such a large chunk, it plays a pivotal role in determining the profitability of airlines and, by extension, the maintenance, repair, and overhaul (MRO) industry. The trend shifted dramatically in 2020, when a significant decrease in fuel prices, coupled with the reduction in flight hours, drove fuel spending down 58% year-over-year. In 2021, fuel prices began to stabilize, but the estimated $100 billion spent on fuel represented just 19% of total operating costs.

According to the IATA outlook, fuel spend in 2022 will increase to $132 billion, which will represent 19.5% of total operating costs. The rise in the fuel expense is based on an estimated jump in the jet fuel price per barrel in 2021 to $77.80 from $74.50 and increased consumption with the recovery of air traffic.

**Exhibit 8: Spot prices of crude oil and jet fuel, 2007–2021**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jet Fuel</th>
<th>Brent</th>
<th>WTI*</th>
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<tbody>
<tr>
<td>2007</td>
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<td>2021</td>
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<tr>
<td>2022</td>
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</tbody>
</table>

*WTI = West Texas Intermediate

Note: Crude prices are calculated by dividing the price by the number of gallons in a barrel

Source: US Energy Information Administration
But there's a long-term trend that should keep the impact of higher fuel prices somewhat constrained. Increased aircraft retirements throughout 2020 pushed many older, less fuel-efficient aircraft out of service. As the production of new generation platforms ramps up and ultimately reaches historical highs, the rate of replacements will accelerate. More efficient aircraft will curb fuel expenditures and help reduce greenhouse gas emissions.

For new deliveries, the ratio of fuel consumption to flight hours will decline from historical rates. As a result, while fuel burn and associated expenditures will increase as demand and flight hours do, fuel's share of operating costs is expected to remain below the 25% historical benchmark.

Labor is the other critical operating expense for airlines, and its share of total operating costs has been growing. The industry's labor market has been choppy, attributable to factors including government relief and uneven travel demand. In a difficult 2020, governments around the world provided crucial relief that helped stabilize aviation's workforces, and the 15.6% decline in employment was less than originally forecast for the year. Total airline industry employment was flat in 2021, but limited staffing left little room for disruptions from bad weather or a wave of COVID-19 absenteeism rippling through the workforce. For instance, many US airlines experienced larger than normal network disruptions during the year because of unpredictable workforce availability.

Unit labor costs, as measured by cents per available tonne kilometer, improved in 2021 but the metric is also affected by reduced capacity. In total, the 2021 unit labor cost was almost 30% above 2019 levels. With industry employment expected to increase 11% in 2022, airlines will need to prioritize productivity and capacity growth. The challenge of hiring and retaining employees will persist in a competitive labor market, as cited by US airline executives during congressional hearings in November.
A GRADUAL RECOVERY

The world's commercial in-service fleet began to grow in 2021 after contracting 18% the year before in response to the COVID-19 pandemic. The number of aircraft expanded by 2,800 to reach 25,500 at the beginning of 2022 — a 12% increase over the size of the fleet in January 2021. But the additional planes only put the fleet at roughly the same size it was in 2017 and still 8% below its pre-COVID January 2020 total, when the count was almost 28,000. The in-service commercial fleet is not expected to recover to its pre-pandemic size until early 2023.

Much of the recovery thus far reflects decisions to return aircraft to service that had been put in storage during 2020 as air travel demand dropped because of COVID-19. In 2021, over 3,000 aircraft, including almost 2,000 narrowbodies, reentered the fleet after sitting in storage for most of 2020.

Thousands of additional aircraft remain in storage, and most of them are expected to rejoin the fleet over the next few years, with timing varying by region. Globally, domestic fleets are expected to recover before international fleets, which will favor the return of narrowbodies that are used primarily to serve domestic markets and non-transoceanic routes. At the beginning of 2022, 50% of the stored fleet were narrowbodies, 25% widebodies, and 25% regional jets or turboprops.

Over 1,200 narrowbodies in storage are expected to resume flying sometime in 2022 as airlines attempt to satisfy strong demand for domestic travel. Oliver Wyman expects the numbers of narrowbodies in the active fleet to recover to pre-COVID levels by midyear. Meanwhile, over 1,100 narrowbodies have been retired in the last two years, 7% of the January 2020 narrowbody fleet.

Widebodies, on the other hand, will return to operations more gradually, given the slower recovery in demand for international travel, often because of COVID-19 restrictions. We expect the widebody fleet to return to pre-pandemic size in late 2023, over a year after narrowbody recovery.

After a challenging 2020 and start of 2021, air travel began to turn around in the spring of 2021 as government vaccine campaigns in developed markets pushed up the numbers of inoculated people and unleashed pent-up demand for domestic travel. Passenger traffic increased through the spring and summer when the fleet experienced steady monthly growth of 2% that continued through the end of the year.

Regional recovery of fleet numbers, however, was uneven. While China's fleet recovered to its pre-pandemic size at the end of 2020 and Eastern Europe's exceeded its pre-pandemic size in June 2021, most other regions trailed their pre-COVID peaks by 5% to 20% at the beginning of 2022.
A ROUGH RIDE FOR NEW AIRCRAFT

After record-low deliveries and production in 2020, aerospace manufacturers faced another tough year in 2021. Production was even lower than in 2020, which benefited from strong production in the first 10 weeks of the year before the pandemic was declared and substantial portions of the global economy were shuttered.

On the bright side, deliveries in 2021 increased more than 25% over 2020 as manufacturers began clearing backlogs of built but undelivered aircraft that started to accumulate even before COVID-19. In March 2019, the 737 MAX was grounded by regulators worldwide with most clearing the aircraft to return to service in late 2020 or early 2021. Almost 25% of the aircraft delivered in 2021 were from the 737 MAX backlog.

Exhibit 9: Monthly in-service fleet, 2019–2024

The US Federal Aviation Administration (FAA) was the first regulator to clear the MAX in November 2020, with the European Union Aviation Safety Agency (EASA) recertifying it in January 2021. In regions where the 737 MAX has been recertified, most aircraft previously delivered to airlines have rejoined the fleet and are operating without issue.

The notable holdout among regulators on MAX recertification has been the Civil Aviation Administration of China (CAAC). In December 2021, the CAAC announced the final changes required for 737 MAX recertification, indicating a return to service is likely to occur in the first quarter of 2022. As of January 1, 2022, nearly 100 MAXs were in storage with Chinese carriers as the recertification process was being finalized.
As of the beginning of 2022, Boeing had shrunk its backlog of built but undelivered 737 MAX aircraft to 267, down from between 400 and 450 the year before. Boeing now expects to clear the backlog by the end of 2023, but that timing is contingent on recertification of the aircraft by Chinese regulators in the first quarter of 2022 since about one-third of the undelivered MAX aircraft are slated to go to Chinese carriers.

Exhibit 10: Regional breakdown of 737 MAX aircraft waiting to join the fleet

Note: Both charts are as of January 2022. Unknown category includes canceled orders and unknown operators
Source: Aviation Week Intelligence Network's Fleet Discovery

**AEROSPACE DELIVERIES AND INVENTORY**

Even with the backlog and aircraft in storage, the outlook for aircraft manufacturers in 2022 is already more positive than what they saw in 2020 and 2021 — with 1,650 deliveries forecast versus actual deliveries of 1,014 in 2021 and 804 in 2020. If realized, the 1,650 deliveries would be only 8% below the levels of 2018, the last full year of deliveries unaffected by either the 737 MAX grounding or COVID-19.

From a production standpoint, the year-over-year growth will not be quite as strong this year as a significant chunk of deliveries — roughly 20% — will come out of manufacturers’ inventory and not off the assembly line.
Almost 70% of those in inventory are either 737 MAXs or 787s. Airbus A320neos, A330neos and A350s make up 20% of the inventory, with the remaining 10% comprised of different regional jets and turboprops. In 2021, Boeing delivered almost 250 737 MAX aircraft, and if it continues deliveries at the same pace in 2022 and 2023, the 737 MAX backlog will be cleared in 18 months.

While the MAX backlog shrank in 2021, the number of undelivered 787 aircraft increased. Boeing paused deliveries twice over supplier quality-control issues — the most recent of which remains unresolved at the beginning of 2022. There are roughly 100 undelivered 787s, which Boeing has said will take about two years to clear once deliveries resume.

Across all platforms and OEMs, the built but undelivered backlog will take a few more years to clear. Production and deliveries are not expected to align again until 2024.

### Exhibit 11: Projected global fleet changes, 2022–2032

<table>
<thead>
<tr>
<th></th>
<th>2022 fleet</th>
<th>2032 fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Passenger fleet</strong></td>
<td>25,578</td>
<td>38,189</td>
</tr>
<tr>
<td>New passenger deliveries</td>
<td>21,195</td>
<td></td>
</tr>
<tr>
<td>Net aircraft returning to service from storage</td>
<td>(8,495)</td>
<td></td>
</tr>
<tr>
<td>Passenger-to-cargo conversions</td>
<td>1,908</td>
<td></td>
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<tr>
<td>Passenger retirements</td>
<td>7,905</td>
<td></td>
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<tr>
<td><strong>Net growth</strong></td>
<td>12,611</td>
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<tr>
<td><strong>Cargo fleet</strong></td>
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<tr>
<td>New cargo deliveries</td>
<td>598</td>
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<tr>
<td>Passenger-to-cargo conversions</td>
<td>1908</td>
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<tr>
<td>Cargo retirements</td>
<td>476</td>
<td></td>
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</tbody>
</table>

Note: Fleet sizes as of beginning of 2022 and 2032
Source: Oliver Wyman analysis
NARROWBODY EXPANSION

Because of the inventory backlog held by manufacturers, the recovery of aircraft production will lag behind deliveries even as the global economy picks up. Only 1,300 commercial aircraft are expected to be produced in 2022. That compares with just over 900 in both 2020 and 2021, but it is more than 25% lower than in 2018 when manufacturers produced almost 1,800 aircraft.

Both Boeing and Airbus have announced plans to increase production rates for narrowbody aircraft over the short term. Boeing has said it will ramp up 737 MAX production to 31 a month in early 2022 and possibly to as high as 42 per month by the fall, but that would still leave production well below the 49 a month it produced in 2018. As domestic demand recovers, Boeing anticipates being able to deliver enough aircraft each month so that it can still draw down its backlog even as it increases production.

Airbus has also announced an aggressive ramp-up of A320 production and is exploring rates as high as 75 per month by mid-decade — a significant increase over the historical high of 53 per month reached in 2019. In 2021, Airbus produced A320s at a rate of 42 per month and plans to produce at 52 per month in 2022 and 65 per month in 2023.

Returning to its pre-COVID agenda, Airbus also plans to increase production of its smaller narrowbody, the A220, to 14 per month by mid-decade. In 2021, it built only about five or six A220s a month.

Over the next decade, Oliver Wyman expects nearly 16,000 narrowbodies to be produced worldwide, with average annual narrowbody production 34% higher than its 2018 level — the last year of normal production before the MAX grounding.

But the ambitious goals of manufacturers may be complicated by supply chain disruption and delays, as well as labor shortages. Many aerospace suppliers were forced to cut output and lay off employees in the first year of the pandemic as the airframe and engine OEMs scaled back production with the drop-off in air travel. Given the rebound in the economy in 2021, employers have been and still are challenged to hire and train new workers fast enough to meet rising demand.

Today's delays in global shipping and in the industrial ramp-up will likewise constrain production by making it hard to access parts and raw materials when suppliers need them. The most recent COVID-19 outbreaks are causing widespread absenteeism, which is also curbing efforts to satisfy rising demand and aggravating understaffing for many parts of the supply chain.
COVID’S LINGERING IMPACT ON WIDEBODIES

While the outlook is for more production of narrowbodies, OEMs have much more conservative goals for widebody production. Widebodies are primarily used for transoceanic, international travel, which is still well below pre-pandemic levels because of travel restrictions imposed by various nations. Arguably, there was already too much widebody capacity pre-COVID. In 2021, widebody production was less than half of 2019 levels, and no ramp-ups as aggressive as for the major narrowbodies have been announced by manufacturers.

Airbus plans for A350 production to return to pre-pandemic levels over the next few years, but production of its A330 family of widebodies is expected to remain between two and three per month, down from five per month in 2018. In total, widebody production is unlikely to return to pre-pandemic rates before the end of the decade. Over the forecast, we expect almost 2,700 new widebodies to be produced, with average annual production 30% lower than the 2019 level.

Exhibit 12: Aircraft production and deliveries, 2019–2031

Source: Oliver Wyman analysis
RUNNING AHEAD OF DEMAND

For airlines to fly mostly full networks, an active fleet larger than the demand is required — one that represents more than a one-to-one aircraft-to-available seat mile ratio. That's because of the geographical and logistical realities that medium and large carriers face in trying to ensure flight-ready aircraft are where they should be when needed. For that reason, the global fleet over the past two years has recovered at a pace faster than passenger demand, just as it declined less sharply than demand in 2020 after COVID struck. In December 2021, passenger RPKs were only 55% of December 2019 levels, but the passenger fleet was at 92% of its pre-pandemic size.

Aircraft utilization has also outpaced the recovery in demand, although it still lags behind fleet recovery. Daily hours and cycles per in-service aircraft saw drastic reductions in 2020, as airlines sought ways to cut capacity without sending aircraft to storage. In 2021, as demand picked up, the average individual aircraft began to see more time in-service each day. At the start of 2021, the average in-service aircraft flew six hours per day; by the end of the year, that utilization rate had risen to 7.9 hours. That, however, was still well short of the 8.6 hours averaged in 2019.

Exhibit 13: Fleet, utilization, and demand recovery curves, 2019–2024

Indexed to Q4 2019

Source: Cirium Fleets Analyzer, Aviation Week Intelligence Network Fleet & Data Services, Oliver Wyman analysis
RETIREMENT TRENDS

Although the full impact of COVID-19 on aircraft retirements won't be understood for years, close to 1,300 aircraft permanently left the fleet in 2020. Assessing retirements in real time can be difficult because of the lag between the decision to remove a plane from service and the official reporting of the retirement.

The annual number of retirements globally in 2021 returned to pre-pandemic levels, about half of what happened in 2020. But not all regions saw a decline in the number of aircraft permanently leaving the fleet: Asia Pacific, for instance, is expected to retire 120 aircraft in 2021, matching its 2020 historic high. And while 2021 retirements in Western Europe are expected to fall to 160 from 290 in 2020, that is still 60% more than the region's pre-pandemic average.

Exhibit 14: Annual retirements, 2011–2021

Over the last decade, North America has typically accounted for about 35% of all retirements. In 2020, this share increased to 45%. Over our 10-year forecast period, North America is expected to increase from its historical average to slightly over 40% of global retirements, with more than 3,200 aircraft expected to retire over the next 10 years. That represents more than 40% of the current fleet in the region. The increase in North American retirements is a function of the age of the fleet, which is currently 14.5 years old and has been steadily rising since 2010.
Only Africa, at 16.7, has a fleet older than North America’s. The third oldest regional fleet — Latin America’s — has an average age of 12.1 years old, more than two years younger than North America’s and over four years young than Africa’s.

Exhibit 15: Replacement rates

Source: Oliver Wyman analysis

Asia Pacific and Western Europe, the second and third largest fleets after North America, will see the second and third highest number of retirements over the forecast period. About 30% of the active fleet in each region is expected to retire over the next decade.

India will have the fewest retirements over the next decade; its current fleet has only 600 aircraft, with an average age of 6.2 years, and the nation will need to increase the size of its fleet to meet the expected rise in passenger demand. On a relative basis, China will retire the smallest percentage of its fleet, with less than 10% of the active aircraft expected to exit by 2032.

In 2021, widebody retirements returned to their historic share of 20% after spiking to 25% in 2020. Narrowbodies’ share of 2021 retirements jumped to nearly 70%, up from 60% in 2019 and 52% in 2020. Narrowbodies’ elevated share in 2021 is a result of the significant decrease in the retirements of regional jets.

After averaging about 100 retirements per year from 2016 to 2019, only 60 regional jets are expected to retire in 2021. More than 200 regional jets left the fleet in 2020 as operators accelerated retirement schedules because of COVID-19.

Retirements of narrowbodies, especially 737NGs and A320ceos, are expected to increase over the forecast period as their next-generation counterparts are attractive replacements. The 737NG and A320ceo have lower fuel efficiency, resulting in higher fuel costs while also being less environmentally-friendly than current production narrowbodies.
With growing concerns about climate change and sustainability, along with operating costs being a consistent challenge, airlines are expected to start retiring previous generation technology at a younger age than historically has been the case. Over the forecast period, Oliver Wyman expects the average retirement age of narrowbodies to drop from 24.9 years between 2015 and 2019 to 22.9 between 2022 and 2031.

Along with the drop in retirement age, narrowbodies permanently removed from the fleet are also expected to have flown fewer cumulative cycles — as much as 20% below their 2015 to 2019 average utilization. Despite the decrease in cycles at retirement, cumulative hours at retirements are expected to be in line with recent history, a reflection of increasing hours to cycles ratios on narrowbody aircraft.

Exhibit 16: Aircraft utilization distribution at formal retirement

![Aircraft Utilization Distribution Graph](image)

Note: Cycles and hours in thousands
Source: Cirium Fleets Analyzer, Oliver Wyman analysis

The retirements of regional jets and turboprops will also change, but trend in a different direction with both age and cumulative utilization averaging higher for retiring aircraft. That is because operators are left with few replacement options so they will keep in-service aircraft in this category longer. For example, CommutAir, a United Airlines regional partner, is investing in interior upgrades on its ERJ fleet, despite its average age of 18, to extend its useful life.

For widebody aircraft at retirement, cycles are expected to fall slightly while their cumulative hours rise 20% from historical averages, a result of increasing hours to cycles ratios.
Even with the COVID-driven retirement surge in 2020, the share of the global fleet that is over 25 has nearly doubled from 5% in 2010 to 9% in 2022 as operators opt to keep aircraft in service longer. Over the next few years, that share is expected to climb to 10%, where it will remain through 2032. In absolute terms, the number of aircraft over 25 that stay in service is expected to almost double, from 2,300 in 2022 to almost 4,000 by 2032. One-third of this growth will come from the cargo fleet, where most aircraft operate well past 25 years of age.

**IN-SERVICE FLEET CHARACTERISTICS**

From 2015 to 2020, the global commercial fleet grew at an average annual rate of 3.4% to 28,000 aircraft in January 2020. At its lowest point in 2020, as COVID-19 surged globally, the fleet shrank to only 13,000 active aircraft, but by January 2021 it had rebounded to almost 23,000 aircraft. From January 2021 to January 2022, the fleet grew 12% to 25,500 aircraft, more than 90% of its pre-pandemic size.

The average age of the fleet between 2015 and 2019 remained constant at about 11.2 years old. By the beginning of 2020, the average age ticked up slightly to 11.5 as a result of the grounding of the 737 MAX that forced airlines to keep flying other aircraft longer.

COVID-19 hit the fleet hard in 2020, with airlines temporarily placing thousands of aircraft into storage and retiring nearly 1,300 aircraft. Still, the average age of the fleet remained unchanged in 2020 and 2021 at around 11.5 years as the removal of older aircraft was offset by the significant reduction in deliveries. By the start of 2022, the average age of the fleet increased to 11.8 years, as delivery numbers remained depressed.
With deliveries over the next few years expected to remain below historical levels, fleet age is forecast to rise through 2024, when it will peak at 12.4 years. After that, it will slowly decrease to 11.4 years by 2032 as aircraft production and delivery increase.

In terms of usage, passenger aircraft represent 91% of the 2022 fleet, a 1.5 percentage point decrease from the share over the last decade. In 2021, passenger aircraft represented 90% of the global fleet, with cargo demand recovering well before passenger demand. While the passenger fleet is still below its pre-pandemic size, the cargo fleet has grown roughly 7% since 2020 with the COVID-related explosion of e-commerce, reduction of belly space in passenger aircraft, and supply chain issues resulting in modal shifts.

From the start of 2020 to 2032, the passenger fleet is expected to grow 2.6% annually versus the average 3.3% growth sustained between 2010 and 2020. The cargo fleet, meanwhile, will expand at an annual rate of 3.3% versus 2.3% from 2010 to 2020.

During the next 10 years, the narrowbody share of the fleet will increase, continuing a pre-pandemic trend. At the start of 2020, narrowbodies made up 58% of the fleet and regional jets and turboprops combined for 21%. By 2032, the narrowbody share is expected to climb to 64%, while regional jets and turboprops will drop to 18%.

Historically, North America and Western Europe have boasted the largest fleets, with the two markets together accounting for 50% of all commercial aircraft. While they have the largest fleets, Western Europe and North America are expected to experience slower growth than most other regions of the world. By 2032, as a result of this slower growth, their share of the global fleet is expected to fall to 40%. China, India, and Eastern Europe are expected to experience strong growth of over 5% annually through 2032.

**AIRCRAFT CLASSES**

Narrowbody growth has come largely at the expense of regional jets and turboprops as the higher seat counts provide better economics for operators than smaller regional aircraft. Over the forecast period, a portion of narrowbody growth will come at the expense of widebodies as the latest narrowbody models include technological improvements, like increased range, which make them capable of flying routes that only widebodies could serve previously. Several airlines plan to fly trans-Atlantic routes using the A321neoLR and XLR, which have lower operating and maintenance costs than widebodies.

The narrowbody fleet reached a low in the spring of 2020 of 6,600 aircraft and bounced back by the start of 2022 to 15,500. That's just 4% fewer than the peak in January 2020 of 16,100.

Demand for new narrowbodies remains strong, and both Boeing and Airbus have announced plans to increase production aggressively. Over the next decade, the narrowbody fleet is expected to see the most robust growth of any class — expanding 3.4% annually. By 2032, they will make up 64% of the fleet, up from their current share of 60%.
New competitors from China and Russia will emerge on the scene over the next decade and challenge Airbus’ and Boeing’s historical dominance. Two new narrowbody airframes, China’s C919 and Russia’s MC-21, will account for 900 deliveries — 5.5% of all new production narrowbodies — over the next 10 years. Regulatory approval of these aircraft outside of their home regions is uncertain, especially in Western Europe and North America, the two largest markets. Still, these new aircraft are expected to be major drivers of growth in their home regions. Over the next 10 years, the C919 is forecast to make up 17% of narrowbody deliveries in China, and the MC-21 will represent 27% of narrowbody deliveries in Eastern Europe.

Exhibit 18: Narrowbody projected deliveries by aircraft platform, 2022–2031

<table>
<thead>
<tr>
<th>Number of aircraft</th>
<th>2022–2031 deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>A319/A320/A321neo</td>
<td>8,113</td>
</tr>
<tr>
<td>737 MAX</td>
<td>5,645</td>
</tr>
<tr>
<td>A220</td>
<td>1,493</td>
</tr>
<tr>
<td>Others</td>
<td>924</td>
</tr>
</tbody>
</table>

Source: Oliver Wyman analysis

After growing 4.3% per year from 2015 to 2020, the widebody fleet is expected to slow to a compound annual growth rate (CAGR) of 2.1% from the start of 2020 through 2032. Demand for new widebody aircraft remains low, and production rates are not expected to reach pre-COVID levels this decade. The one bright spot for widebodies is cargo aircraft. Demand for widebody freighters is solid, with both deliveries and conversions unhurt by COVID-19. With passenger deliveries reduced, over 30% of widebody aircraft delivered in 2021 were freighters, a share historically closer to 10%.

Widebodies come in two sizes: large and extra-large. Production of extra-large widebodies is set to end in 2022, when the final 747-8F is completed. The current extra-large fleet skews heavily toward cargo aircraft after airlines retired nearly 130 passenger extra-large widebodies in 2020 and 2021. Hundreds more extra-large widebodies sit in storage, awaiting the return of international travel demand, but some may end up facing early retirement.

Over the forecast period, cargo extra-large widebodies will continue to account for the majority of extra-large aircraft, although the gap between cargo and passenger will narrow as passenger extra-large widebodies come out of storage. In 2022, cargo aircraft represent 70% of the extra-large fleet, but that percentage will drop to 50% by 2032.
Regional jets represent the third largest class at 13% of the current fleet, down from a 16% share in 2010, but about the same as at the start of 2020. Similar to the rebound for narrowbodies, the regional jet fleet is currently at close to its pre-pandemic size, at 94%, lifted by the strong recovery in domestic demand in 2021. Over the forecast, the regional jet fleet is projected to grow at a CAGR of 0.7%, in line with its 0.6% growth between 2015 and 2020. Though the fleet will reach 3,800 aircraft by 2032, its share among the classes will slip to 10% as both narrowbodies and widebodies grow faster.

Regional jet growth is primarily limited by the lack of suitable replacements for the current fleet. Though operators have trended toward higher seat counts to improve the economics, there is still steady demand for aircraft with fewer than 100 seats. With limited replacement options, many regional jets have flown well past their historical retirement ages. The average age of the 360 in-service CRJ-100/200s is 19, over a year older than the average age of all CRJ-100/200s that have already retired. Similarly, the E170 fleet is two years older than the average age at retirement. While operators have been able to extend the useful lives of these aircraft beyond the historical retirement age, there is a limit on how much longer they can keep them in service. Inevitably, over the next decade, most of these aircraft will leave the fleet.

The lack of replacements hits hardest in the United States, the largest regional jet market with over half of the fleet. The E2 E-Jets, the successor to the original E-Jet, do not meet current US operator scope clause requirements, eliminating them as an option for regional carriers in the US without new agreements between airlines and pilot unions. The Chinese-made ARJ and Russian-made Superjet are unlikely to gain certification in the US, making the E1 E-Jets the only production aircraft
that can replace the aging fleet. Even with the indefinite pause of the Spacejet program, it is likely that a new regional jet will enter the market as a replacement aircraft for the North American fleet.

Turboprops, the smallest aircraft class at 9% of the January 2022 fleet, have reached 85% of their pre-pandemic size with a fleet of 2,100. Over the forecast period, the turboprop fleet is expected to grow less than 1% annually to almost 2,800 aircraft in 2032, and its share of the fleet will drop to 7%.

Between 2015 and 2020, the turboprop fleet shrank a little less than 1% annually because there was not enough production to replace retiring aircraft. But with demand somewhat steady, manufacturers are expanding turboprop options. First, there are two new platforms expected to enter the market over the next ten years— the Xian Modern Ark 700, a Chinese-made turboprop, and the Cessna SkyCourier, a cargo turboprop ordered by FedEx. Over the forecast period, the two are expected to account for some 300 deliveries. In addition to these announced platforms, another OEM is expected to enter the market in the latter half of the decade with a new 70- to 90-seat turboprop using a clean sheet design.

Improvements are also being made to existing turboprop aircraft. At the end of 2021, Pratt and Whitney announced an updated version of the PW127 engine that powers the ATR. The new version has lower maintenance costs and longer intervals between required overhauls.

**Exhibit 20: Global fleet forecast by aircraft class, 2020–2032**

<table>
<thead>
<tr>
<th></th>
<th>Number of aircraft</th>
<th>CAGR 2020–2027</th>
<th>CAGR 2027–2032</th>
<th>CAGR 2020–2032</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>27,884</td>
<td>0.0%</td>
<td>0.1%</td>
<td>2.2%</td>
</tr>
<tr>
<td>2027</td>
<td>32,521</td>
<td>1.8%</td>
<td>1.6%</td>
<td>3.3%</td>
</tr>
<tr>
<td>2032</td>
<td>38,189</td>
<td>1.8%</td>
<td>1.6%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

Note: Fleet sizes as of the beginning of the year; CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis
AIRCRAFT USAGE

Over the forecast period, passenger aircraft will continue to command the largest share of the fleet, but the cargo portion will see faster growth, thanks initially to the surge in demand generated by COVID-19. The cargo fleet is expected to grow 3.3% annually, reaching 3,100 aircraft by 2032 versus 2.6% per annum growth for the passenger fleet, which we project will expand to 35,000 by the end of the forecast period.

Because of COVID-19’s suppression of air travel, the passenger fleet will account for 91% of the total commercial fleet in January 2022, down from its pre-pandemic share of 92.5%. We expect the passenger fleet’s share to normalize at around 92% as COVID-19 recedes and passenger demand fully recovers.

One bright spot has been that while the passenger fleet shrank 10% between 2020 and 2022, the number of aircraft in the cargo fleet rose almost 7%.

The increase in cargo demand over the last two years generated a corresponding rise in the number of passenger-to-freighter conversions. In 2021, there were well over 100 aircraft converted, a record high and above the typical 60 to 70 conversions seen in the years pre-pandemic. The number of conversions is expected to remain above pre-pandemic levels throughout the forecast period, given an expansion of conversion capacity by several MRO providers as well as new conversion programs for the 777 and A321.

Demand for direct-build freighters has remained steady through COVID-19, and new platforms are likely to emerge over the forecast period. In summer 2021, Airbus announced it will offer a direct freighter version of the A350 to enter service mid-decade, and in early 2022 Boeing unveiled the direct freighter version of the 777X. The Cessna SkyCourier, a new cargo turboprop announced before the emergence of COVID-19, is still on track for its first delivery to FedEx in 2022. Meanwhile production rates for the 777-200LRF and 767 freighter are at or exceeding pre-pandemic levels. That said, production of both is likely to end within the next five years as neither is in compliance with new International Civil Aviation Organization noise and emissions standards, which would prevent Boeing from selling them after 2027 without significant redesign.

In total, almost 600 cargo deliveries are expected over the forecast period, a 50% increase from the 10 years before COVID-19 struck. Historically, nearly all cargo deliveries have been widebodies, but more than 50% will be turboprops over the forecast. The new SkyCourier will account for 200 of the 300 cargo turboprop deliveries, with the ATR 72 the other 100.
**REGIONAL TRENDS**

While many regions across the world are projected to see slower growth than they did before the pandemic, the overall fleet is still likely to enjoy steady compound annual growth of 2.7% between 2020 and 2032, down from 3.2% growth between 2010 and 2020.

During our forecast period, growth will vary regionally, with mature, developed regions like North America and Western Europe experiencing slower rates of gain than will emerging regions. Asia, including China and India, is projected to contribute over half of the global fleet growth over the next decade, with China alone responsible for 30% of that global growth.

Although China was the first country with a COVID-19 outbreak, the coronavirus had a relatively small impact on its commercial fleet. At its depths, the fleet shrank 22% versus 50% for the global fleet. Worldwide, China was also the only region to grow in 2020, and by the beginning of 2022 its fleet was 7% larger than in January 2020. Over the forecast, China is expected to grow at a CAGR of 5.4%, double the global average.

China is also expected to increase its presence in commercial aerospace, with investments made over the past decade culminating in deliveries over the next decade. China has been aggressively investing in its domestic production capacity, and we expect 25% of regional deliveries over the forecast to come from three domestically manufactured platforms — the ARJ, ModernArk, and C919. Still, all widebody deliveries and 85% of narrowbody deliveries will come from Boeing and Airbus.
India's fleet, like China's, rebounded quickly, and rising passenger demand is fueling strong long-term growth projections. After almost the entire fleet was parked in spring 2020, it rebounded to 90% of its pre-pandemic size by the start of 2021. When COVID-19 cases surged in India in mid-2021, the fleet contracted less than 5% as operators kept their aircraft in service. Instead of parking aircraft to adjust for decreased demand, operators reduced the utilization of the in-service fleet, with hours per active aircraft declining over 50%. India is projected to have fastest fleet growth of any region at 7.5% annually between 2020 and 2032, although it is also starting from the smallest base.

The outlook is less rosy in Asia Pacific, the only region where the fleet is 80% of its pre-COVID size. The fleet experienced limited recovery in 2021, as the Delta variant and associated lockdown measures hampered travel demand. The regional fleet remained at or below its January 2021 size until November, when growth in the fleet began to return. In particular, Indonesia saw a significant decline, with a fleet that was 20% smaller in January 2022 than in January 2021. Asia Pacific, already the third largest global region, is forecast to see 2.6% fleet growth annually over the next 10 years. This makes it a slower growth region than China and India, but in line with the global average. Still, Asia Pacific will be a significant contributor to overall fleet expansion, responsible for 16% of global growth over the forecast.

**Exhibit 22: Fleet growth by region, 2022–2032**

North America, the largest fleet in the world, had one of the strongest recoveries of any region. The fleet currently sits at 96% of its pre-pandemic size and has grown roughly 2% each month since March 2021, when widespread vaccination distribution began in the region. Over the forecast, North America is expected to grow 1.4% annually, a slight slowdown from the 1.8% annual growth it experienced in the five years before COVID-19. Even with these modest gains, the region, because of its large size, will produce 15% of global fleet growth through 2032.
The outlook for Western Europe, the second largest region, is less optimistic than for North America. Currently, the fleet is at 85% of its pre-COVID size, ahead of only Asia Pacific and the Middle East in recovery. This lag toward the end of 2021 resulted from a slowdown in growth after the summer travel season. Between April and August, the fleet gained on average over 5% per month, but since August it has slipped to growth of less than 1% monthly.

Long-term growth is forecast at just 0.6% annually, the slowest of any region. As a mature market economy, Europe’s growth rate has lagged in recent years, and the region is rebounding more slowly from COVID-19 than, say, the US. In addition, climate pressures, which affect the entire industry, are particularly prevalent in Europe, where alternative modes of transportation like trains can be a viable substitute for air travel. Many European countries have announced carbon emissions goals that could affect the viability of air travel, at least with current technology. Full recovery is not expected for a few years, making it the last region to return to its pre-pandemic size.

Eastern Europe has a more positive outlook than its Western neighbor. The fleet has already surpassed its pre-pandemic size, and strong growth is expected to continue through 2032, averaging 5.5% annually. The post-COVID growth outlook is more than a percentage point increase from the pre-pandemic trend. The region has a strong narrowbody order book, with over 500 aircraft on order through the end of the decade — 200 of them A320neos for Wizz Air. By 2032, the Eastern Europe fleet will nearly double in size from 1,500 aircraft in 2020 to 2,800 in 2032, accounting for 13% of global growth.

**Exhibit 23: Share of the fleet by region, 2020–2032**

![Exhibit 23: Share of the fleet by region, 2020–2032](image)

Source: Oliver Wyman analysis
The Middle East is another region where the post-pandemic outlook is more optimistic than it was pre-COVID. The region is heavily reliant on international travel, with a fleet that has historically been over 50% widebody aircraft, compared with the global fleet average of 20%. Because of this reliance on international traffic, the region's fleet is one of the least recovered, at only 85% of its pre-COVID size. However, long-term growth for the region is forecast at 4.5% annually, in part because of a strong narrowbody outlook. In total, the region has almost 700 narrowbodies on order through the end of the decade spread out among more than 15 operators. With an influx of narrowbody aircraft expected, the widebody share of the fleet is expected to drop below 50%, and by the end of the decade narrowbodies will overtake widebodies as the largest class.

The two remaining regions, Africa and Latin America, are currently at 90% of their pre-COVID size and have the same long-term growth projections of 1.3% annually. However, they will achieve this growth in different ways. In Africa, where operators place limited orders for new aircraft, the fleet grows mostly through the migration of aircraft from other regions. Over the 10-year forecast, Africa is expected to receive fewer than 300 new deliveries. As a result, the average fleet age will grow from 15.4 years in 2022 to 20 years by 2032.

Pre-COVID, the fleet in Latin America saw a slight decline between 2016 and 2020. Already on shaky economic ground, multiple large airlines declared bankruptcy during the pandemic. Despite this, the fleet has bounced back quickly and, at the start of 2022, stood at 90% of its pre-pandemic size. However, full recovery is expected to stretch into the middle of the decade, with growth driven largely by the 600 narrowbody aircraft on order through 2030.
MRO MARKET FORECAST
FLEET CHANGES HIT MRO SPEND

Two years of the COVID-19 pandemic, significantly fewer aircraft deliveries, and a raft of premature retirements have taken their toll on the maintenance, repair, and overhaul (MRO) industry. Like passenger travel, aftermarket service demand is on the rise, but the predictions for growth in demand are more restrained than they were pre-pandemic.

The MRO market in 2022 and beyond is being reshaped by a fleet in transition. With a record number of retirements in 2020 and the annual average age expected to increase over the forecast period, MRO growth will be slower than in the previous decade. Even so, global MRO demand is expected to recover fully to pre-COVID levels by 2023. By 2030, MRO demand is expected to reach $118 billion, 13% below the pre-COVID forecast of $135 billion.

How did the industry get here? Before the COVID-19 pandemic, the commercial MRO market saw strong, steady growth for more than a decade, thanks to a worldwide economic expansion that spurred increased demand for air travel. In turn, the commercial fleet increased in numbers and average age, which drove MRO demand.

Then in early 2020, the COVID-19 pandemic struck, ending years of the industry's consistent upward trajectory. Suddenly, operators faced the need to revamp fleet and utilization strategies to match demand.

The most immediate effects of the COVID-19 pandemic in 2020 were the mass storage of aircraft — both old and new — and changes in aircraft utilization, both flight hours and cycles. More than half of the global fleet was stored at the beginning of the pandemic, and the aircraft that remained in service flew fewer hours per day. Operators cycled through fleets, optimized green-time on engines to delay shop visits as long as possible, and put off most non-essential maintenance and modifications. Originally projected at over $90 billion, 2020's MRO spend ended up below $55 billion, a brutal contraction.

The pandemic's negative impacts continued into 2021, albeit with less severity. New outbreaks of COVID-19 and the travel restrictions imposed in response by many countries slowed traffic recovery and stalled operators' plans to add back capacity.

While the active fleet grew every month after February 2021, utilization per aircraft stagnated during periods when operators attempted to align capacity to declining demand. But demand proved to be a moving target, and, despite carrier efforts, there was significant excess seat capacity, reflected by global load factors of less than 70% on an annualized basis.

For MROs, this mismatch between capacity and demand was a net positive because it meant more aircraft were flying — and would therefore require maintenance. The bottom line for MROs would have been worse if airlines could have matched demand and capacity more accurately in 2021.
In total, MRO spend in 2021 is estimated to have been just over $62 billion, a 17% increase from 2020 but 31% below 2019. Spending related to engines, components, and line maintenance fell sharply because of the reduced utilization. On the other hand, airframe check spend proved more resilient because most checks occur on calendar time intervals that don't stop when an aircraft is stored. Aircraft that passed certain intervals while in storage must have those checks completed before they can return to service.

Regionally, 2022 will be a very different year for MRO growth and recovery in various parts of the world. Compare the outlooks for China, North America, and Asia Pacific: While the Chinese active fleet was already larger by the end of 2021 than in January 2020 and the resulting MRO demand higher than pre-pandemic, MRO in North America won't reach 2019 demand until later in 2022. By contrast, the recovery of the Asia Pacific fleet, a significant driver of MRO demand globally pre-COVID, has lagged behind other regions; its 2021 MRO demand was 38% below that of 2019. It is not expected to fully recover until 2024.

What's holding back MRO globally in 2022? There were a record number of retirements in 2020, with almost 1,300 aircraft estimated to have left service permanently. While many of those aircraft were older and operators had already begun phasing them out, hundreds of younger aircraft were retired early as operators adjusted their fleet plans for a post-pandemic environment.

Moving forward, aircraft manufacturers are making a strong effort to increase production rates, particularly across narrowbody platforms. Without a significant increase in passenger demand above baseline expectations, this effort is likely to lead to more aircraft retirements over the decade. Consequently, MRO growth during the late 2020s, will be slower than in the previous decade, as the honeymoon period for these new aircraft gives airlines time before facing significant maintenance.

By the end of the forecast period, MRO growth will stabilize at a compound annual growth rate (CAGR) of 2.8% from 2027 to 2032.

**BEHIND THE DEMAND**

The softer MRO demand growth expected over the forecast period partly reflects the significant reduction in deliveries in 2020 and 2021 — with a total of only 1,800, half of what has historically been delivered over a two-year period. In addition, aircraft production lines have been slow to ramp up to pre-COVID levels, given the inventory of already built aircraft the OEMs are sitting on. Together, they mean fewer maintenance events involving newer aircraft during the middle of the forecast period.

Most aircraft delivered in the next couple of years will not reach their first significant maintenance visits until after 2030, resulting in a plateau in MRO spend during the latter years of the forecast period.
MRO demand grew 17% in 2021 and is forecast to gain 26% in 2022, reaching 87% of 2019 levels. From 2022 to 2024, MRO demand is expected to rise 12% annually, a total increase of roughly $20 billion, as fleet size and utilization gradually return to pre-pandemic levels. Maintenance events delayed in 2020 and 2021 while aircraft were in storage will also provide a short-term boost in airframe check and some engine shop visits.

In total, 2021 deliveries were almost 45% below those in 2018, the last year without delivery disruptions. Deliveries continued at lower levels through 2021 but are expected to climb in 2022, given announced production rate increases and expected clearing of OEMs’ inventory. Though delivery and production aren’t expected to recover to 2018 levels until 2024, the acceleration will provide a noticeable boost in the short term, particularly for line maintenance. Engine MRO demand will see strong growth in 2031 and 2032 — eclipsing $65 billion — as these aircraft begin expensive shop visits and the replacement of life-limited parts (LLP). In total, from 2024 to 2032, MRO demand is expected to grow 3.2% annually as these higher production rates introduce more aircraft into the market.
IMPACT ON MRO SEGMENTS

Airframe MRO

In the next two years, airframe MRO is expected to be the most resilient segment as calendar-time thresholds drive most major inspections. While regulators and OEMs have allowed short-term flexibility in scheduling airframe maintenance because of the pandemic, aircraft in storage that are past due for their checks must undergo the service before they can return to flying.

More than 3,300 stored aircraft returned to service in 2021; over 2,400 are expected to leave storage in 2022, of which more than 1,700, or 75%, must undergo significant airframe checks. The anticipated mass return to service in 2022 and 2023 could create an airframe demand bubble in the labor-intensive MRO segment. That could pose a challenge in some regions like North America and Europe, where aging workforces have seen a raft of early retirements and there are too few sufficiently trained candidates to fill the empty slots. Inadequately prepared airlines risk not having enough aircraft in service to meet passenger demand. At the start of 2022, airframe maintenance slots were filling up quickly, and some reports indicate that slots in North America may soon be booked for all of 2022.

Exhibit 25: Total MRO demand forecast by segment, 2019 and 2032

Primarily driven by this surge of aircraft returning to service, 2022 airframe spend is forecast to be just 8% lower than it was in 2019 — a far smaller gap than other MRO segments will see versus 2019. In total, airframe MRO spend is expected to recover to sustainable 2019 levels by 2026.
When splitting airframe MRO between checks and modifications, airframe check spend in 2022 is forecast to reach 98% of 2019 levels, thanks to the bubble of stored aircraft returning to service. Check spend will remain flat from 2022 to 2024 as the bubble clears and standard scheduled checks resume.

Modifications spend is expected to stay below 2019 levels through the end of the forecast. The likely increase in narrowbody retirements means there will be fewer older aircraft in the fleet that will require modifications. Additionally, the new generation aircraft that replace these can go years without requiring any significant modifications, further depressing demand.

From 2025 to 2032, airframe MRO is expected to inch up 0.9% annually despite fleet growth of 3.3%. Along with depressed modifications spend, this growth is limited because new generation aircraft, which are less costly to maintain because of extended check intervals and fewer manhours per check, will make up a larger percentage of the fleet. While airframe MRO is expected to account for 24% of MRO spend in 2022, its relatively slow growth in subsequent years will cut its share to 17% by 2032. By comparison, new generation aircraft will make up 51% of the fleet in 2032 compared with 11% in 2022.

One likely consequence of the shift toward narrowbodies and away from widebodies is an imbalance in the supply and demand for airframe MRO among regions. Asia Pacific, the region to which widebody heavy maintenance is most often outsourced, may see its capacity underutilized while hangar space tightens in other regions of the world that cater more to narrowbodies.

Flight hours and utilization impact on MRO

For other MRO segments, the impact of COVID-19 is expected to be more significant than it was for airframe. Maintenance for engines and most components is driven by their utilization, primarily accumulated flight hours and flight cycles. With the precipitous COVID-related drop in demand, operators were forced to store aircraft and cut utilization on those remaining in service. As a result, the total number of hours and cycles plummeted, directly affecting engine, component, and line MRO. Utilization rebounded in 2021, particularly in Eastern Europe, India, and Latin America, but remains below pre-pandemic levels.

In 2019, utilization data provided by Aviation Week Intelligence Network Fleet & Data Services showed that the average in-service narrowbody jet flew 8.8 hours a day and the average in-service widebody almost 13 hours a day. Regional jets and turboprops, which typically fly less, averaged around six hours and four hours per day, respectively. Early in the pandemic, utilization of narrowbodies, regional jets, and turboprops reached a low point in spring 2020, when hours and cycles per day fell almost 50% versus the same period of 2019. At the same time, the active fleet contracted over 50% for these aircraft classes. The combination of the fleet size and utilization per aircraft decreases caused total flight hours to slide substantially in 2020.
After reaching a floor in April 2020, average utilization per aircraft climbed steadily through the rest of 2020, reaching 70% of its pre-COVID rate. With the fleet still almost 20% smaller, total monthly flight hours — the key metric for MRO demand — remained more than 40% below its pre-COVID level. When the second global wave of COVID-19 struck in early 2021, utilization fell slightly, hitting a low for the calendar year in February. Since then, the fleet has grown consistently at a monthly rate of 1.3% as utilization recovered. By the start of 2022, utilization per active aircraft was trending at 90% of pre-pandemic levels. The pace of MRO recovery over the next several years will be directly tied to utilization recovery.

Exhibit 26: Flight hours per aircraft by class

<table>
<thead>
<tr>
<th>Year</th>
<th>Narrowbody</th>
<th>Widebody</th>
<th>Regional jet</th>
<th>Turboprop</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>120</td>
<td>80</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>2021</td>
<td>100</td>
<td>80</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>2022</td>
<td>110</td>
<td>90</td>
<td>70</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: Aviation Week Intelligence Network Fleet & Data Services, Oliver Wyman analysis

**Engine MRO**

With a significant number of aircraft still in storage and lower utilization of the active fleet, engine MRO demand for 2021 was 38% below 2019 levels. With aircraft returning to service and average utilization per aircraft expected to approach historical norms throughout 2022, engine MRO is forecast to grow 33% year-over-year but will still be 18% below 2019 levels.

While utilization is making a slow comeback, engine MRO must also cope with another factor that could depress its growth in coming years — the impact of green-time engines from COVID-related early retirements. Many aircraft were retired for operational expediency, not just age, and therefore had engines with sufficient hours and cycles to power an aircraft for a year or two. These engines can replace those due for maintenance, allowing operators to delay the cost of shop visit. With nearly 1,300 aircraft estimated to have left service permanently in 2020, there were an estimated 1,900 engines with usable green-time available. This supply is expected to defer over 1,600 scheduled shop visits from 2021 to 2025, saving operators almost $1.4 billion in that period.
By 2024, annual engine MRO spend is expected to recover to 2019 levels. From 2025 to 2032, engine demand is forecast to grow at a CAGR of 4.4%, driven primarily by a fleet expansion of 3.3% annually. Engine MRO growth is expected to outpace fleet growth primarily because the engines that power new generation aircraft contain more expensive materials. As they make up more of the global fleet over time, they will drive higher engine MRO spend.

**Component and line MRO**

Component MRO will fully recover to 2019 levels in 2023. After a reduction of over 30% in 2020 and a slight recovery in 2021, component MRO demand is expected to reach 89% of 2019 levels in 2022. Component MRO is made up of dozens of Air Transportation Association (ATA) chapters, but most demand is concentrated within a few chapters. The top three chapters, consisting of wheels and brakes, auxiliary power units, and avionics, will account for 40% of total component spend. In fact, the top 10 ATA chapters by spend are expected to represent almost 74% of the component MRO market over the forecast period. After recovery, the component market is projected to grow at a CAGR of 2.1% annually.

In 2022, line maintenance will remain 12% below 2019 spend, with full recovery not expected until 2023, according to baseline projections. The distribution and growth of line maintenance spend closely matches the distribution and growth of the fleet. In 2019, narrowbodies made up 58% of the fleet and 63% of line maintenance; by 2032, narrowbodies are expected to reach 64% of the fleet and 67% of line maintenance spend. Following fleet recovery, line maintenance is expected to grow at a CAGR of 3.4% from 2025 to 2032, while the fleet grows at a CAGR of 3.3%.

**Exhibit 27: MRO market forecast by aircraft class, 2019–2032**

<table>
<thead>
<tr>
<th></th>
<th>CAGR 2019–2027</th>
<th>CAGR 2027–2032</th>
<th>CAGR 2019–2032</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.5%</td>
<td>2.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td>2019</td>
<td>-1.3%</td>
<td>-1.4%</td>
<td>-1.3%</td>
</tr>
<tr>
<td></td>
<td>-0.7%</td>
<td>2.3%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>3.4%</td>
<td>2.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td></td>
<td>2.4%</td>
<td>3.8%</td>
<td>2.9%</td>
</tr>
<tr>
<td>2027</td>
<td>110.6</td>
<td>126.9</td>
<td></td>
</tr>
<tr>
<td>2032</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis
TYPE OF PLATFORM

On an annual basis, total MRO spend will exceed 2019 levels in 2024. All aircraft classes will recover to 2019 levels over the forecast except for turboprops. Instead, the turboprop market will peak at 96% of 2019 MRO, then decline through the end of the forecast period. The turboprop fleet will grow less than 1% annually, and many older maintenance-intensive turboprops will be replaced by more efficient ATRs with longer honeymoon periods before their first major maintenance visit.

Regional jets and widebodies will both recover to 2019 demand levels in 2023, with year-over-year growth in 2022 of 18% for regional jets and 32% for widebodies. Full-year narrowbody MRO demand is not expected to recover until 2024 because of the expected increase in narrowbody retirements over the next few years. Those retirements will mean fewer expensive maintenance visits for late-life aircraft while the new replacement aircraft won't generate much MRO demand for several years.

Narrowbody and widebody aircraft comprise most of the fleet and will also be responsible for the majority of MRO spend over the next 10 years. However, across all MRO segments, widebodies have a disproportionately large share of MRO spend relative to their fleet size. This is most pronounced in engine MRO, with widebodies historically accounting for half of all engine spend but only about 20% of the fleet. This trend is expected to continue in 2022 despite lower utilization.

In 2022, widebodies are expected to comprise 42% of total MRO spend but only 19% of the active fleet. That share of MRO demand remains constant throughout the forecast, while widebodies' fleet share increases slightly. Narrowbodies will drive 47% of MRO spend in 2022 on 60% of the fleet. By 2032, narrowbodies are expected to reach 64% of the fleet and 50% of MRO demand.

The top 10 platforms

The majority of MRO spend has long been concentrated in the top 10 platforms, which evolve over the years with the arrival of new aircraft. In 2019, the top 10 platforms were responsible for 84% of MRO spend. In 2032, the top 10 platforms are again expected to account for 84% of MRO spend.

Four new generation platforms — the A320neo, 737 MAX, A220, and A350 — will enter the top 10 in 2032 as older platforms, including the A380, 747 and 757, drop out. In 2032, the top 10 platforms will be evenly split between narrowbodies and widebodies, but narrowbodies will hold the top two spots.

The 737 MAX is still expected to be a major platform, but its extended grounding in 2019 and 2020, combined with COVID-19, tempered its long-term growth potential. Roughly 40% of the undelivered backlog was placed with operators in 2021, with the remainder to be delivered through 2023.

Even so, the lost MAX production that began with the 2019 grounding will impact MRO spend in the latter half of the decade. By 2032, the MAX is expected to account for 40% less MRO demand than the A320neo.
AN AGING FLEET

Along with fleet size and utilization, fleet vintage is a major driver of MRO demand. In 2019, aircraft developed in the 1990s accounted for 66% of the fleet and 68% of MRO spend, while new generation aircraft developed in the 2010s formed 2% of the fleet and less than 1% of MRO. At the start of 2022, this ratio has shifted, and those developed in the 1990s account for 59% of the fleet, while new generation aircraft compose 11%.

As more 1990s vintage aircraft retire over the next 10 years, their share of the fleet will decline, but they will still have a disproportionately large share of MRO because of their advanced age. By 2032, 1990s vintage aircraft are expected to account for 25% of the fleet and 32% of MRO. Aircraft developed from 2010 to 2019 are projected to increase to 51% of the fleet but 37% of MRO, given that only a small portion of that fleet will reach expensive heavy checks or engine shop visits by the forecast's end.
At the start of 2022, the average in-service aircraft was 11.8 years old, half a year older than at the start of 2019. The rise in fleet age results from decreased deliveries because of COVID-19 and issues with the 737 MAX. By 2024, the average age is expected to increase to 12.3 years, then decline to 11.4 by the end of the forecast as deliveries ramp up. Although the average age will return close to its 2019 number, the share of the fleet over 25 will remain elevated. In 2022, 9% of the fleet is over 25, compared with 8.5% in 2019. By 2032, the share of the fleet over 25 will climb to 10.5%. In absolute terms, there will be 4,000 aircraft over 25 in service in 2032, up from 2,400 over 25 in service in 2019.

Exhibit 29: Total MRO spend by aircraft vintage, 2019 versus 2032

REGIONAL DIFFERENCES

COVID-19 altered growth trends worldwide, with regional recovery and growth in the MRO market mirroring the recovery and growth of the fleet in each region of the globe.

The fleets in Eastern Europe and China mostly serve domestic markets, and domestic travel had recovered or almost recovered to 2019 levels by the end of 2020. The China fleet has grown 8% from January 2020 to January 2022 and is forecast to have a 20% larger MRO market in 2022 than in 2019, making it the only region expected to surpass pre-pandemic levels of MRO in 2022.

By 2032, China's MRO market is projected to be twice as big as it was pre-pandemic, reaching $19.2 billion. Its share of the world fleet will increase to 18% by then from 12% in 2019. Along with fleet growth, the average age of the fleet in China is expected to increase from 6.4 to 10 years old, driving the rise in MRO demand.
The Asia Pacific region, on the other hand, is more dependent on international travel, and pandemic travel restrictions limited its fleets’ growth in 2021, creating a longer path to MRO recovery. Full recovery in MRO demand within the region is not expected until 2024.

Similar to projections for their fleet sizes, MRO demand growth in North America and Western Europe is expected to lag behind most other regions at less than 2% annually. Both regions are expected to see sluggish growth in their fleet sizes post-recovery, with the average age of the Western Europe fleet falling from 11.8 years in 2020 to 11.2 in 2032, limiting MRO demand. The average age of the North American fleet over the forecast will decline two years to 12.4 by 2032. As other regions outpace its growth, North America is likely to see its MRO share slip from 24% in 2019 to 21% in 2032, while Western Europe’s MRO share drops from 22% to 16% over the same time.

Exhibit 30: Total MRO demand forecast by region, 2019 versus 2032

India’s fleet, which is just below its pre-pandemic size, is expected to more than double by 2032, with corresponding growth in the MRO market forecast. The Indian MRO market, growing to $4.6 billion, will also double by 2032. Currently, India has limited domestic MRO infrastructure, with only 5% to 10% of its carriers’ needs fulfilled within the country. Even with COVID-19 case surges in spring 2021 and early 2022, India is expected to increase its market share from 2% of global MRO demand in 2019 to 3.6% in 2032. Despite this strong growth, India will be the second smallest MRO market in 2032, ahead of only Africa.
Africa, which pre-COVID had the second smallest MRO market, will grow at a CAGR of 1% over the forecast. Africa has the oldest fleet but a disproportionately small share of MRO demand. In 2032, Africa is projected to have the smallest share of the fleet at 3.5% and an even smaller share of MRO at 2.8%. Globally the fleet is roughly 20% regional jets and turboprops, which are less expensive to maintain than narrowbodies and widebodies. But in Africa, these two classes comprise 45% of the fleet, depressing MRO demand.

Of all the regions, the Middle East is the most dependent on the recovery of international travel to fill its widebodies. Before COVID-19, widebodies made up over 50% of the Middle Eastern fleet versus only 21% of the global fleet. Because of this dependence, the Middle East MRO market is not expected to recover until late 2024. One factor that could partially offset the lag in international demand is the large number of narrowbodies scheduled for delivery to the region’s carriers over the next decade. Once international demand recovers, the Middle East outlook stabilizes with MRO growth of more than 4.8% annually as the young fleet grows at a CAGR of over 4.7% between 2024 and 2032.

The Latin America MRO market is not expected to return to its pre-pandemic size until 2032, making it the last region to recover. The fleet in the region is expected to grow at a CAGR of 1.3% and is unlikely to reach its pre-COVID size until 2025. With over 500 aircraft — a third of the region's current fleet — expected to retire, MRO market recovery will stagnate because the new replacements won't need significant MRO for years. Additionally, operators in Latin America utilize their aircraft less than do most other regions, further delaying the new deliveries' first expensive shop visits and component repairs.
Exhibit 31: Projected turboprop deliveries by aircraft platform, 2022–2032

US$ in billions

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2027</th>
<th>2032</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turboprop</td>
<td>96.5</td>
<td>110.6</td>
<td>126.8</td>
</tr>
<tr>
<td>Regional jet</td>
<td>0.6%</td>
<td>2.3%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Large widebody</td>
<td>0.5%</td>
<td>2.9%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Extra-large widebody</td>
<td>-0.9%</td>
<td>-5.7%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Medium narrowbody</td>
<td>4.6%</td>
<td>1.1%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Small narrowbody</td>
<td>-2.2%</td>
<td>21.0%</td>
<td></td>
</tr>
</tbody>
</table>

Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

Exhibit 32: MRO market forecast by segment, 2019–2031

US$ in billions

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2026</th>
<th>2031</th>
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<tbody>
<tr>
<td>Line</td>
<td>96.5</td>
<td>110.6</td>
<td>126.9</td>
</tr>
<tr>
<td>Component</td>
<td>2.3%</td>
<td>3.1%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Airframe</td>
<td>0.8%</td>
<td>0.8%</td>
<td>-0.2%</td>
</tr>
<tr>
<td>Engine</td>
<td>2.2%</td>
<td>3.7%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis
Exhibit 33: Projected widebody deliveries by aircraft platform, 2022–2031

Source: Oliver Wyman analysis

Exhibit 34: Projected regional jet deliveries by aircraft platform, 2022–2031

Source: Oliver Wyman analysis
Exhibit 35: Projected turboprop deliveries by aircraft platform, 2022-2031

Source: Oliver Wyman analysis
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