



Pilot and Technician Outlook 2022–2041



Introduction

Boeing's 2022 Pilot and Technician Outlook (PTO) projects that 602,000 new pilots, 610,000 new maintenance technicians, and 899,000 new cabin crew members will be needed to fly and maintain the global commercial aviation fleet over the next 20 years.

This forecast is limited to the commercial aviation sector, and assumes that air traffic demand will recover to 2019 levels by 2024. Consistent with last year's forecast, this year's outlook does not include business aviation and civil helicopter demand.

Commercial air travel recovery remains uneven as countries manage their market recoveries in disparate ways. Passenger demand has recovered to near pre-pandemic levels in many areas of the world and will accelerate as travelers regain a sense of safety and security. In the cargo market, accelerated e-commerce adoption spurred by the pandemic is likely to sustain freighter growth trends. To prepare for the recovery and subsequent growth, the aviation industry will need a long-term strategy that addresses upcoming labor challenges. Investment in early career-development programs and in tactics

that spark excitement among future aviators will be essential to a healthy aviation market for years to come.

The aviation industry has proven resilient time and again despite major external and macroeconomic shocks. This historic persistence is driven by global commerce and business travel, as well as people's desire to visit family and friends and to explore the world. While periodic market downturns are challenging, operators, in time, tend to resume their growth trajectories through collaboration, adaptation, and innovation. Accordingly, some operators today have emerged from the pandemic with updated business models that will foster sustainable and profitable growth.

However, the aviation industry's pandemic-imposed shocks have not followed typical patterns, and the overall market has struggled to adjust. The demand for training and related

services has shown signs of faster recovery, but the industry still faces lingering challenges. Among them are insufficient training capacity to support a significant personnel shortage, and the lag time involved in bringing personnel online while prioritizing safety.

This outlook assumes continued investment in an uninterrupted pipeline of qualified personnel to replace those who either reached retirement age or opted for voluntary early retirement during the pandemic. The return of personnel furloughed during the pandemic will provide only limited relief, as many have already left the industry. As a result, competition to recruit and retain top-tier talent will be strong as more flights and routes are added. At the same time, the industry is experiencing a juniority across the workforce, further reinforcing the importance of relevant, affordable, and accessible training.

Introduction

Fortunately, innovation is widespread. Personnel trained since the start of the pandemic have encountered new solutions adopted by schools, training providers, and regulators. Digital technologies, virtual formats, and other developments have helped bridge gaps in subject matter while improving the delivery and implementation of training. Methodologies continue to advance toward a holistic approach focused on competencies rather than prescriptive, task-based syllabuses. As commercial operators and training providers plan for the future, we will see new investments in artificial intelligence, machine learning, and mixed reality that will help tomorrow's students learn more quickly, efficiently, and effectively, and will lead to a safer, more efficient aviation industry.

Forecast Methodology

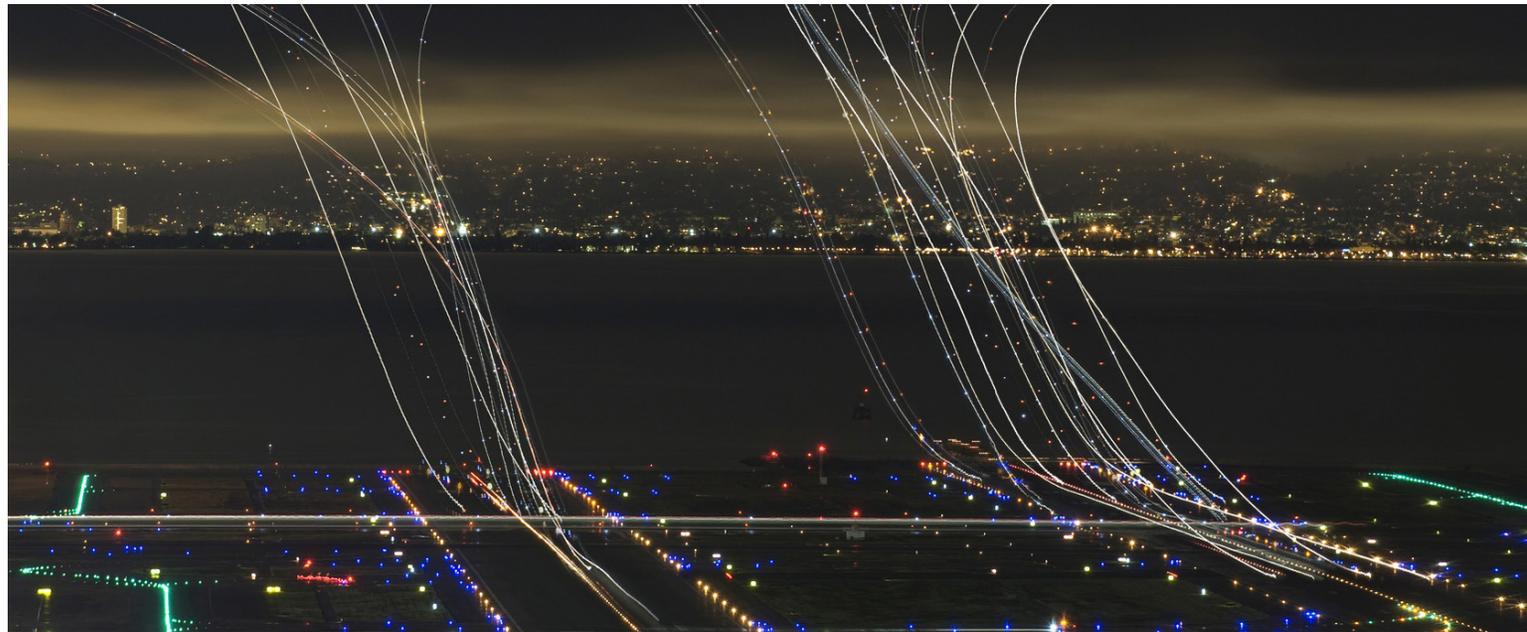
New personnel demand is calculated on the basis of a 20-year fleet forecast for commercial aircraft with more than 30 seats. By analyzing fleet growth, aircraft utilization, attrition rates, and regional crewing differences specific to aircraft type, Boeing's PTO estimates the number of new pilots, maintenance technicians, and cabin crew members that will be needed worldwide.

Year-over-year forecasts may vary due to factors that include regulatory changes, crew productivity, and aircraft

mix. This year's forecast does not include assumptions for single-pilot commercial airplane operations, but it does consider impacts from alternative modes of transportation such as advanced air mobility and high-speed rail. Boeing continues to track the market for indications of regulatory movement and will update upcoming forecasts accordingly.

This year, Russia's war in Ukraine has had a direct impact on the aviation industry, most notably that it will not be possible to deliver airplanes in Russia. Although there is demand for

pilots, technicians and cabin crew in the Russia and Central Asia region, there is a high level of uncertainty of how long this situation will persist. For that reason, Boeing has chosen not to publish a pilot, technician and cabin crew forecast for this region.



Air traffic demand has begun to recover in many markets around the world, occasionally surpassing 2019 levels in some countries.

Vaccine access has increased dramatically, travel restrictions have eased, and people are eager to travel. The resulting surge in demand for pilots has restored many of the jobs affected by the pandemic, and created openings for new pilots. While the industry refocuses on recovery and growth, operators must plan to ensure adequate staffing of qualified pilots to fly their routes.

Because the industry already was heading toward a global pilot shortage before the pandemic, many airlines instituted cadet pilot programs to fill their talent pipelines. Operators that paused or cancelled these programs during the pandemic will likely resume their focus on new pilot development. Concurrently, the industry as a whole must address a global shortage of certified flight instructors.

However, accelerated training efforts will take years to pay off, while experienced pilots are in short supply today. Two factors have driven the shortfall globally and regionally: During the downturn, many junior pilots lost their jobs; some will not return, having changed careers and left the industry altogether. Through the same period, numerous veteran pilots accepted voluntary early retirement packages; those who remain will no longer be able to fly commercially once they reach the mandatory retirement age.

As a result, competition for qualified pilots will remain strong over the next few years. New pilots will have much to gain by building hours in flight instruction and through opportunities in government, business aviation, and general aviation. Aspiring pilots who begin flight training today will

be positioned to seize emerging opportunities by the time they graduate.

For the airlines, the pandemic meant significant uncertainty and change. Airline network planning and scheduling teams, for example, had to adapt to increasingly dynamic market conditions as flight bookings became more spontaneous and crew availability grew less predictable. These conditions are expected to persist in the near term, driving a temporary need for reserve pilots to fill anticipated gaps.

Flight-training scheduling will remain a challenge as the surge in air traffic stimulates pilot recalls and hiring. The reasons are twofold: Pilots may need additional training before they return to the flight deck if their currency or type rating certifications have lapsed.

Pilots

Additionally, as airlines adjust their fleet mixes to meet demand, increasing numbers of pilots will be required to complete qualification or differences training.

While many aspects of training have transitioned to digital formats over the past two years, full-flight simulator training time is expected to remain a constant in commercial flight training. Training methodologies are evolving to focus on proficiencies and competencies rather than prescribed tasks, and it is expected that these priorities will gradually come to dominate the flight training curriculum.

In conclusion, demand for pilots is likely to soar. Projections indicate that, over the next 20 years, 602,000 new pilots will be needed to meet demand from commercial operators.



Technicians

The aviation maintenance market has endured a number of pandemic-related challenges, led by the large-scale parking of the global fleet.

Operators have employed various strategies to stem the outflow of cash, including deferments of non-critical maintenance that subsequently impact the labor market. Technician demand is, however, expected to recover robustly within the next few years.

As air traffic increases and aircraft come out of storage, aviation technicians will play a vital role in inspecting, repairing, and restoring them to airworthiness. While technicians have been busy in aircraft and engine preservation over the past two years, the near term will require additional labor to bring airplanes back into service. These complex tasks, including extensive checks, maintenance, and cleaning, can occupy each team for several weeks per aircraft.

Technicians are critical to operational safety, and they play a key role in supporting the industry's recovery. But in some cases they're spread thin. They are leaving the workforce through retirement and natural attrition, and retirements will accelerate over the next five to ten years. All the while, fleets are expected to continue to grow. In mature aviation markets, the average age of the technician workforce keeps rising, while the number of new entrants to the profession tapers off. Educational outreach efforts will be necessary to reverse this trend, and knowledge transfer to junior workers will remain essential to conserve critical expertise and specialized skills.

Meanwhile, the role of the aviation maintenance technician continues

to evolve as new generations of aircraft join the global commercial fleet. New sensors and flight data recorders generate torrents of data, enabling maintenance providers to implement new, predictive solutions. These innovations drive demand for technicians who can accurately analyze, interpret, and act on the information generated. At the same time, older aircraft remain in service, requiring providers to employ technicians with vast skillsets who can maintain and repair aircraft built decades ago. In short, the coming years will demand flexible training that addresses not only traditional maintenance but also emerging, analytical skillsets.

Technicians

Already, prospective and current technicians can enhance their skills and knowledge with learning technologies and methodologies introduced since the pandemic. COVID-19-related restrictions accelerated the industry's transition to virtual learning, and it is expected that investments in modern and non-traditional instruction platforms will continue. The long-term outlook for learning modernization is positive, as schools and industry providers adapt to attract a new generation of students.

Over the next 20 years, 610,000 new technicians will be needed to meet demand from fleet operators and providers of maintenance, repair, and overhaul services. The combination of fleet growth, attrition, and replacement will continue to drive high demand for the foreseeable future.



Cabin Crew

The cabin crew profession remains an attractive career for those interested in aviation, travel, and customer service.

Cabin crew members will remain essential to ensure passenger safety and comfort, as well as to provide services that enable airline brand differentiation.

Cabin crew members maintain a high level of professionalism as they work to ensure the safety of their passengers and the airplane. While typically known for customer service, their primary mission is to ensure safety in the cabin. Increasingly, cabin crew members are called upon to resolve, manage, and defuse disruptive situations.

Cabin crew members are trained to respond to the most likely disorderly scenarios. This training is increasingly supplemented with augmented and virtual reality for more immersive learning experiences.

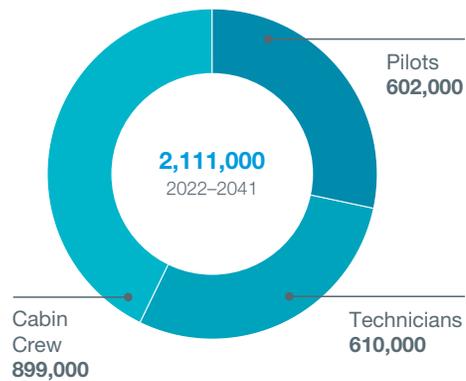
On a related front, training in cabin hygiene and sanitation is expected to remain a high airline priority, as health and safety continue to concern passengers. In addition, refresher courses and skills training will be in demand for cabin crew members who have been recalled from furlough or have been away from service for extended periods.

Finally, regulatory requirements, attrition, replacement, and business-model differentiators will drive strong cabin crew demand across the industry. Over the next 20 years, 899,000 new cabin crew personnel will be needed to meet demand from airlines.

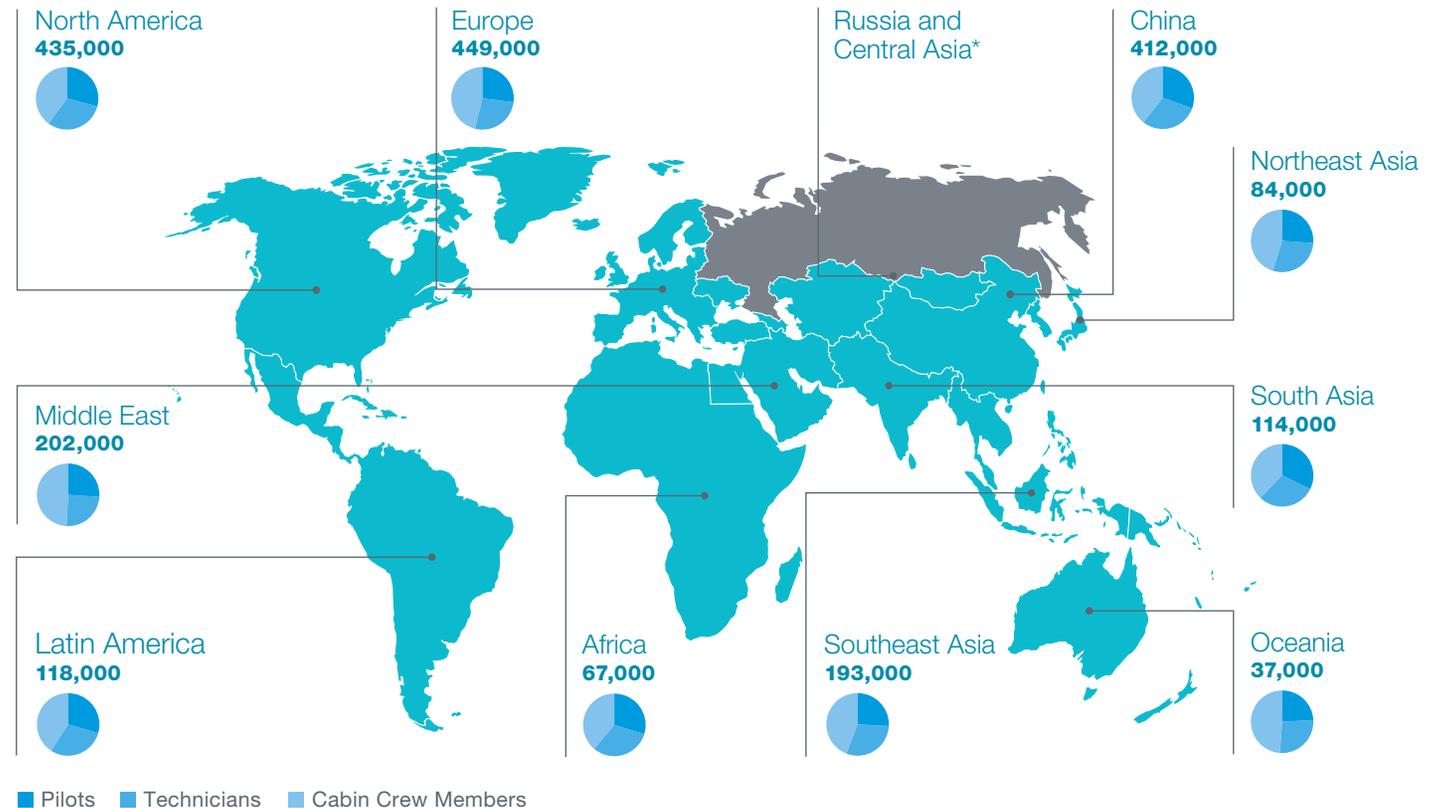


Pilot and Technician Outlook by Region

New Personnel Demand



Market Outlook Summary



*PTO 2022 does not include a forecast for new personnel in Russia due to sanctions against aircraft exports.

Outlook on a Page

New Personnel Demand

| Region | Africa | China | Europe | Latin America | Middle East | North America | Northeast Asia | Oceania | South Asia | Southeast Asia | World |
|---------------------|--------|---------|---------|---------------|-------------|---------------|----------------|---------|------------|----------------|-----------|
| Total New Personnel | 67,000 | 412,000 | 449,000 | 118,000 | 202,000 | 435,000 | 84,000 | 37,000 | 114,000 | 193,000 | 2,111,000 |
| Pilots | 20,000 | 126,000 | 122,000 | 35,000 | 53,000 | 128,000 | 22,000 | 9,000 | 37,000 | 50,000 | 602,000 |
| Technicians | 21,000 | 124,000 | 120,000 | 35,000 | 50,000 | 134,000 | 24,000 | 10,000 | 34,000 | 58,000 | 610,000 |
| Cabin Crew | 26,000 | 162,000 | 207,000 | 48,000 | 99,000 | 173,000 | 38,000 | 18,000 | 43,000 | 85,000 | 899,000 |





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