

2022 Aerospace manufacturing attractiveness rankings

A geographic assessment for aerospace manufacturing investments

January 2023



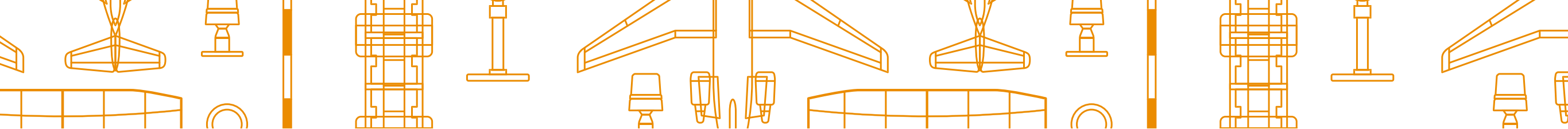
PwC's ninth annual aerospace manufacturing attractiveness rankings offers a guide to — and a ranking of — promising geographic locales for aerospace development. Our attractiveness index examines relative strengths across numerous key variables for locations globally and within the United States. We hope that this edition will provide data that can inform investors and manufacturers in both the civil/commercial and defense spheres as they seek locations that support their strategic vision.

Overview

This year's rankings suggest a rapidly evolving investment landscape across the global civil and military aviation manufacturing industries as they strive to respond to an economy drastically altered by war in Europe and ongoing pandemic-related challenges. This picture contrasts with our data on the US domestic A&D industry that shows impressive resilience in the face of both expected and unexpected market changes.

To provide essential context for our rankings, let's begin by surveying recent developments affecting outcomes and prospects in both the countries and the states we highlight this year. Compared to our 2021 rankings report, there's often surprising news across the entire sector, in both civil aviation (including cargo) and military aerospace. And for manufacturers and investors in both areas, greening all aspects of the industry emerged in 2021-22 as an ever more urgent priority.





Civil aviation manufacturing's trajectory rises.

Civil aviation manufacturing demand is naturally most directly driven by the demand for passenger (pax) travel, which airlines constantly strive to anticipate. Travel demand recovery in 2021 and 2022 was bifurcated, with pax demand surging in large domestic markets such as the US, Brazil and China, while long-haul international travel — both business and leisure — remained slack. Overall, international travel demand isn't expected to recover to 2019 levels until 2025 — while, in most countries, domestic demand recovery is expected to get there in 2023.¹

With domestic pax demand rebounding and sustaining high levels, the core challenge for airlines is not so much filling seats as managing costs. Airlines currently have the advantage of considerable pricing power. Ticket prices in 2022 rose about 25%,² a surge that travelers proved overall willing to accept: online spending for domestic flights, for example, rose to \$8.8 billion in March — 28% higher than its pre-pandemic level.³ Travel demand surges continue to encounter capacity constraints in some key markets caused by persistent shortages in such support functions as security screeners and ground crew.⁴

A return to industry-wide prosperity may depend heavily on addressing supply chain challenges. Parts shortages disrupted pax travel in mid-2022, compounding airlines' staffing shortages. While A&D manufacturing infrastructure has largely survived the 2020-21 pandemic demand shock intact, component and assembly providers below the OEM and Tier 1 levels are facing a liquidity crunch that may inhibit a smooth return to 2019 production levels.⁵ A widespread shortage of highly skilled aviation engineers also intensified in 2021-22, as many had left the field for other industries.⁶ In fact, high-level international concern on the engineer shortage dates back more than a decade.⁷ Only concerted long-term investment in education and training will ultimately resolve this problem, which appears to be even more severe than the much-commented-upon pilot shortage affecting many airlines.⁸

Rising pay is likely to be a top incentive to attract and retain talent in the cockpit. An agreement between Delta and its pilots' union (still to be ratified as of January 2023) would increase salaries by more than 30% over four years and include a raft of enhanced benefits.⁹ Once ratified, the deal is likely to be influential across the industry.

One increasingly concerning consequence of the war in Ukraine is the A&D industry's dependence on Russia as a source of titanium, an indispensable commodity for aviation manufacturing. While Russia produces only 13% of the world's titanium, supply chains for the metal mined in many other countries run through Russia.¹⁰ Airbus relies on Russia for about half of its titanium needs, Boeing about one-third.¹¹ No sanctions have yet been levied on the Russian commodities exporters involved, such as VSMPO-AVISMA, but aviation manufacturers are bracing for supply disruptions and rising prices.



Boeing and Airbus orders and deliveries rebound. Just as in 2021, 2022 was a year of recovery for civil aviation manufacturers after the 2020 plunge that interrupted a decade of inexorable growth. Still, a return to pre-pandemic output levels appears to be some way off. Supply chain problems continue to hinder both Boeing and Airbus as they strive to fulfill a slew of new orders from carriers seeking to expand, rejuvenate and/or green their fleets.¹² In 2021 Airbus edged out Boeing in both net orders and deliveries for the third consecutive year.¹³ Airbus is likely to lead in deliveries in the near to medium term, given its deeper backlog.¹⁴

There was news in 2022 surrounding several safety-related developments at Boeing.

- One of the consequences of the 737 Max crashes in 2018 and 2019, which led to a two-year global ban on the model, is renewed FAA restrictions of Boeing's self-regulation privileges.¹⁸
- US investigators concluded that the China Eastern Airlines Boeing 737-800 crash in March 2022 was probably intentional (on the part of one of the pilots), not an accident.¹⁹
- In September 2022, Boeing settled with the SEC for \$200 million in a securities fraud suit in which the regulator accused the company of misleading investors regarding problems with the 737 Max.²⁰
- Delta announced in July an order for 100 737 Max 10s, expressing confidence that the model will win regulatory approval, with delivery expected in 2025 and an option for an additional 30 planes. The jets will have a higher seating capacity and will be 20% to 30% more fuel efficient than the aircraft they will replace.²¹



For the full year 2021, Boeing delivered 340 aircraft, compared to 157 in 2020 and 380 in 2019. These figures are well below the company's 2018 record of 806 jets — before COVID-19 and the 737 MAX grounding — a level Boeing could reach again by 2025.²² Meanwhile, in 2021 Airbus delivered 611 aircraft (up from 566 in 2020, but far below the 2019 record of 863).²³ New orders versus backlog for both companies also diverged. In 2021, Boeing booked 479 net new orders while Airbus booked 507. By the end of October 2022, Airbus had reported a backlog of 7,397 jets (92% A220 and A320ceo/neo narrowbodies). Boeing's backlog was 5,323 aircraft (80% 737 NG/MAX narrowbodies).²⁴ However, Boeing received a boost of good news in December 2022 with United's announcement that it intends to buy 100 787 twin-aisle Dreamliner jets, with deliveries to begin in 2024 and an option to buy 100 more. The aircraft, which will largely replace aging and less fuel-efficient 767s and 777s, brought United's total orders at Boeing to 700 planes by 2032.²⁵

Boeing's manufacturing volume has its greatest impact in Washington State (7th in our rankings this year), where the company has four factories, as well as in North Carolina (3rd place this year) and Louisiana (28th), where Boeing has assembly facilities. Airbus' prospects affect not only France (16th this year), where the company is headquartered, but also Alabama (13th), Canada, the UK and Spain (all featured in our rankings below).

In business travel, corporate private jet purchases surged in 2022 as spending in the sector reached a ten-year high.²⁶ That could be good news for the world's largest producers of such aircraft, including Canada's Bombardier and Brazil's Embraer. In the US, Gulfstream (Savannah), Honda Aircraft Co. (Greensboro, NC), Nextant (Cleveland), as well as Beechcraft and Cessna (both headquartered in Kansas) all could stand to benefit from this trend. Whether this represents a serious

long-term shift in corporate travel away from commercial flights to company-owned planes remains to be seen. By fall 2022, US domestic business travel had reached about two-thirds of its pre-pandemic level, while international business travel remained at about half.²⁷ Business flight's prospects for 2023 remain highly uncertain as companies cut back on nonessential expenses and brace for inflationary headwinds.



While air cargo declined in 2022, long-term prospects appear bright. Global air cargo declined slightly overall in 2022 beginning in March,²⁸ after outperforming pax traffic from the pandemic's 2020 outbreak through 2021 (and providing a critical cash flow lifeline to many passenger airlines) with 18 months of record-setting volumes and revenues.²⁹ Lower cargo volumes were due mainly to reduced consumer online shopping and a post-lockdown shift from goods to services, as well as somewhat restored pax bellyhold space. Meanwhile, demand for main-deck freighter conversions continued to soar through 2022 as long-haul pax traffic remained relatively diminished.³⁰ Growth prospects in 2023 will likely be tied to high inventory levels and the future trajectory of China's strict anti-COVID-19

policies, which were relaxed in December for the first time following widespread protests. Nonetheless, long-term growth prospects for the air freight industry appear very promising. Boeing forecasts global air cargo traffic to double over the next two decades, increasing the world's freighter fleet by 60%, to more than 3,600 jets (with two-thirds of the fleet being conversions).³¹ Small- to medium-size cargo craft will likely also continue to undergo technological experimentation and innovation to develop greener civil fleets.

Military aviation: War in Europe spurs growth and innovation

The central narrative of the world's defense industry over the last decade — and its trajectory for the decade to come — is likely to be unrelenting growth.³² Total global military spending in 2021 surpassed the \$2-trillion mark for the first time, increasing by 0.7% in real terms and rising to USD\$2.113 trillion.³³ The five largest contributors to this record all-time high were the US, China, India, the UK and Russia, which together accounted for 62% of defense expenditures.³⁴ However, with 2021's steep economic recovery over the prior pandemic lockdown year, military spending fell marginally as a share of global GDP, from 2.3% in 2020 to 2.2% in 2021.³⁵ Collectively, the top ten global defense companies earned \$485.5 billion, with average revenue growth of 7.1%.³⁶ Revenues of the world's top 100 defense companies likewise climbed for the sixth year in a row.³⁷

For military aviation manufacturing, Russia's invasion of Ukraine could have profound, long-lasting consequences. The Ukraine war has amounted to a "beta test" for some newer, advanced Western weapons systems, including Delta, an American real-time information system used for precision targeting.³⁸ The US and other NATO countries are also draining arsenals of many weapons directly related to aviation,



new and old, and struggling to replenish them.³⁹ The list includes missiles, rockets and drones of many kinds as well as anti-aircraft and other surface-to-air defense systems. It also includes aircraft such as light attack jets from Lithuania,⁴⁰ helicopters from the UK⁴¹ and various models of Soviet-era MiG jets from former Soviet-bloc nations⁴² — to name just a few. Many older (especially Soviet) systems cannot and should not be replenished by more of the same. Eastern European members of NATO are especially eager to acquire newer and more advanced Western munitions and materiel.⁴³ The Biden administration announced \$2.2 billion in military aid in September 2022 to 18 nations, from the Baltic to the Mediterranean, precisely to address this urgent need.⁴⁴

Meanwhile, Ukraine's creative innovations in drone warfare,⁴⁵ which have given it an edge over a much bigger adversary,⁴⁶ could have a transformative effect on both military technology and tactics. Some ad hoc, homemade adaptations of commercial drones have been surprisingly effective.⁴⁷ A late-October strike on the Crimean port of Sevastopol revealed that Kyiv had even invented a clever — and devastating — sea-surface drone, apparently based on a jet-ski.⁴⁸

Strikes on airfields and other targets deep inside Russian territory in early December⁴⁹ appeared to show that Ukraine had developed an aerial drone with the astonishing range of up to 1,000 kilometers.⁵⁰ Apparently based on a Soviet-manufactured surveillance UAV, the weapon could reach most of European (western) Russia.⁵¹ As Russia struggled to respond, the two countries by late 2022 were in effect fighting “the first full-scale drone war” ever⁵² — potentially a turning point in military aviation history.

An era of sustained, elevated demand in military aerospace is almost certainly upon us. While the precise contours of the surge cannot yet be mapped, the industry may well look back on Russia's invasion of Ukraine as a moment in military aviation history as decisive as either of the twentieth century's world wars. And in July 2022, industry leaders took note of an ominous unprecedented joint address by FBI and MI5 officials warning against the threats posed by Chinese espionage to long-term global economic security.⁵³ As they said, echoing statements by Taiwanese officials, a Chinese invasion of Taiwan, were it ever to take place, would dwarf the Ukraine war's disruptions.⁵⁴



Technological innovation: Leaders seek to green the global fleet

Demand for more fuel-efficient aircraft and cleaner fuels has been building for years. The unprecedented, record-setting spikes in jet fuel prices⁵⁵ sparked largely by the Ukraine war has only intensified the urgency for greener aviation. Indeed, this partly explains 2022's surge in green-aviation start-ups, as explained in our recent deep-dive analysis based on the 2022 edition of PwC's global aerospace and defense: Annual performance and outlook. The accelerating demand to decarbonize aviation is already stimulating technological research that could lead to important breakthroughs.⁵⁶ Looking ahead, we foresee that the aircraft of the future will be lighter, and some may be radically different in form from what we know today.⁵⁷ A raft of new battery technologies could help accelerate the development of electric and hybrid-electric aircraft, and even potentially enable so-called flying cars to transform commuting around major cities through urban air mobility — before the end of this decade.⁵⁸

American Airlines gave a strong boost to electric aviation in 2021-22 by pre-ordering 250 VX4 “flying taxis”⁵⁹ from the UK firm Vertical Aerospace (VA),⁶⁰ with electrical power units (EPUs) developed by Rolls-Royce in place of engines. Pending regulatory approval, the craft could be in service in 2025. VA announced it has 1,400 other such conditional pre-orders from top airlines globally. United likewise has placed a big bet on electric aircraft, announcing in September 2022 an order for 200 planes from Eve Air Mobility, an Embraer subsidiary, on top of 200 the airline ordered in 2021 from California's Archer Aviation. It's not only urban commuting that's greening: Hawaiian Airlines is investing in “seaglidors,” all-electric craft that fly just a few feet above water and could partly replace conventionally fueled interisland flight by 2028.⁶¹



At the same time, growing industry-wide commitments to developing sustainable aviation fuel (SAF)⁶² — synthetic and biofuels — are also driving innovation, with support from the US Department of Energy.⁶³ The widespread adoption of SAF for large commercial airliners faces significant challenges,⁶⁴ and hovers today at around just 1% of fuel available on the market.⁶⁵ Nonetheless, the target of 10% SAF by 2030 has become widely accepted by both PAX and freight companies over the last two years.⁶⁶ Meanwhile, multiple US government agencies have adopted the goal of 100% SAF by 2050.⁶⁷ And IATA has set a convergent goal of achieving net zero by the same date, with 65% SAF.⁶⁸

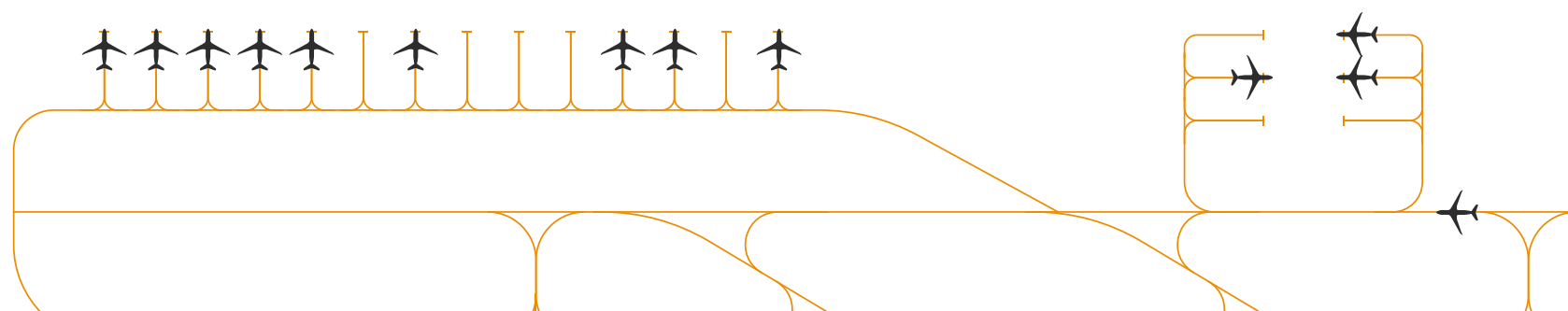
Close analysis of carbon offset programs,⁶⁹ including those popular in civil aviation, underscores the urgency of SAF R&D: the carbon offset market is still far from the maturity needed to make it truly effective in reducing emissions. However, as PwC has reported with regard to EU SAF targets, analysis also indicates that SAF production at scale will dramatically lower costs and could result in more rapid adoption.

Meanwhile, experiments in making conventional fuel-burning engines more efficient continue: Airbus announced plans in mid-2022 to test open-fan turbine engine on an A380 that could reduce carbon emissions by 20%,⁷⁰ and the Australian company Aviation H2⁷¹ announced in May 2022 its plans for the first ammonia-powered jet flight in 2023.⁷²

Supersonic civil aircraft are attracting investor and major airline interest as well. For example, both United and American have committed to purchasing Boom's supersonic Overture jet, which is designed to be the world's fastest sustainable supersonic airliner, capable of flying on 100% SAF.⁷³ Overture has also attracted defense interest, with Northrop Grumman Corporation and Boom Supersonic announcing

that the companies will work together to offer the US government and US allies a supersonic special-mission aircraft.⁷⁴ A field long dominated by defense contractors saw acceleration in 2022 of a shift toward civil aerospace startups such as Atlanta-based Hermeus,⁷⁵ which raised \$100 million in funding in March.⁷⁶ The full disruptive potential of passenger or cargo craft that could, say, cross the Atlantic in two hours may not be realized for a decade or more. Yet advances in AI, heat-resistant materials and engine technology are likely to keep the industry on a rising trajectory toward hypersonic craft. Years (and billions of dollars) further off still are single-stage-to-orbit hypersonic planes launching satellites and other cargo out of Earth's atmosphere. Other US companies in the field to keep an eye on are Houston-based Venus Aerospace⁷⁷ and Radian Aerospace⁷⁸ in Bellevue, Washington.

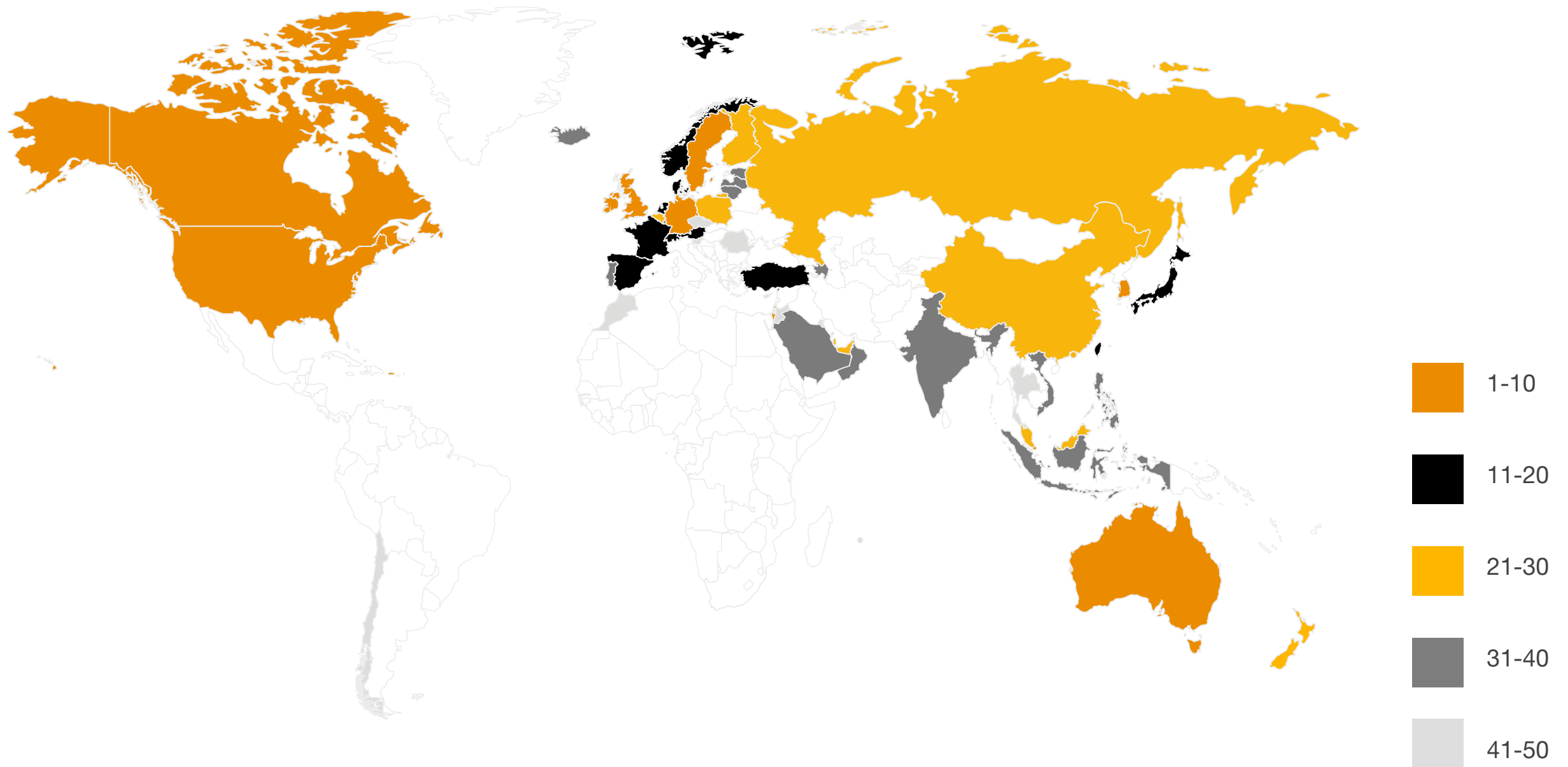
Speed need not be aviation's only new story. A long-defunct mode of air travel gave signs of reawakening in 2022: airships. In an intriguing development linking this year's 4th- and 5th-ranked countries in our rankings, the Spanish airline Air Nostrum ordered a fleet of 10 Airlander 10 100-passenger helium airships⁷⁹ manufactured by Hybrid Air Vehicles (HAV)⁸⁰ in Yorkshire. The blimps are slated to go into service in 2026 on regional routes in Spain. They will boast a range of 4,000 nautical miles, cruising low and slow, at up to 20,000 feet and 80 mph. Compared to comparable-capacity jets, the HAV craft could reduce emissions by 75% (a diesel model) to 90% (a hybrid model), while also being able to take off and land almost anywhere. As more countries announce mandates for decarbonizing short-haul domestic and regional routes, could we witness a new era of dirigibles?



Country rankings

Our rankings

The PwC rankings are based on a weighted score of category and subcategory rankings. The categories for our country rankings are cost, economy, geopolitical risk, infrastructure, labor, industry and tax policy. The categories for our state rankings are the same, with one exception: since we consider geopolitical risk to be similar for all states, we exclude it from state rankings. Each category comprises multiple discrete metrics that are aggregated and weighted to arrive at the final rankings. While both state and country rankings use comparable metrics, there are slight differences in each measure's relevance to the ranking and the availability of quantitative information.



Top 10 country/region rankings for aerospace manufacturing attractiveness

Country/ region	Final Rank	Cost	Labor	Infrastructure	Industry	Geo Political Risk	Economy	Tax Policy
Singapore	1	14	4	4	5	1	7	7
United States	2	4	3	8	2	2	6	25
Canada	3	2	1	20	7	5	12	19
United Kingdom	4	17	7	10	8	13	4	27
Israel	5	7	13	22	13	21	13	13
Ireland	6	3	16	28	20	18	25	4
Germany	7	20	12	7	3	7	16	46
South Korea	8	16	28	2	19	26	5	21
Australia	9	4	21	17	11	12	10	28
Sweden	10	15	11	15	14	11	27	31

Below is a closer look at the top five countries in our ranking. Our top-three countries this year — Singapore, the US and Canada — have all maintained a top-three status since 2017, for an impressive five years running. Just below the medalists' podium, however, there is news, as the UK rises from 7th place in 2020 to 4th this year, while Israel shoots up to 5th from 18th. (It is worth noting that 2020's 4th- and 5th-place finishers, South Korea and Australia, respectively, both retain top-ten status in our survey and remain highly appealing targets for investment.)

Singapore

Singapore, which has never ranked below third place in our survey, tops our list this year with a significant uptick in our metric for geopolitical risk (to 1st place, from 12th) despite dropping from 3rd to 14th place in cost.


Government support for the industry in 2020-21 that focused on labor force investment — mainly reskilling in anticipation of an altered sector post-pandemic ecosystem⁸¹ — appears to have paid off. Singapore aviation is expected to have restored up to 90% of its workforce by end 2022,⁸² and its A&D industry is projected to grow with a CAGR of 12% in 2023-28.⁸³ Singapore typically accounts for 10% of global MRO output, and 2022 saw important investments in this area, as major players expanded their operations. In February, Collins Aerospace announced a long-term MRO agreement with Singapore Airlines and Scoot, the carrier's low-cost subsidiary, to support their fleet of 55 Boeing 787s.⁸⁴ Safran Electronics & Defense Services Asia also announced a major expansion of MRO activity at its Singapore site.⁸⁵

As in many other countries, the Singaporean aviation defense sector was well insulated from pandemic demand shock and even grew in 2020. In an effort to counter Chinese military threats, Singapore launched a significant procurement expansion program in 2022, including the inauguration of a new Digital and Intelligence Service branch, which could drive defense sector growth and attract foreign investment going forward.⁸⁶

United States

In 2021, the A&D sector continued to support nearly 2 million US jobs.⁸⁷ The US A&D market is expected to grow from \$700.3 billion in 2021 to \$755.24 billion by the end of 2022 (i.e., at a CAGR of 7.8%) and to reach \$1047.07 billion in 2026 (CAGR of 8.5%).⁸⁸ Final figures for US A&D exports for 2021-22 are not yet available as of this report's publication but will likely be driven by massive American donations of materiel to Ukraine. There is little doubt that exports will grow and solidify A&D as a leading US export industry. Foreign direct investment in US aerospace reached \$22.4 billion in 2020, strongly led by UK firms.⁸⁹ US aerospace FDI grew slightly in 2021, though the number of projects recorded remained at about half of 2019 figures.⁹⁰

Federal legislation passed in 2022 constitutes a major effort to secure US microchip supply chains and is likely to have significant consequences for US A&D. The problem at issue: US firms account for 48% of global microchip sales, but domestic manufacturers today make only 12% of them (down from 37% in 1990).⁹¹ The law, Creating Helpful Incentives to Produce Semiconductors for America, passed in July 2022 and known as the CHIPS Act, seeks to restore US semiconductor R&D and manufacturing — and especially to protect the sector from industrial espionage and competition.⁹² The CHIPS Act could have profound implications for the entire US semiconductor ecosystem, as PwC has detailed — and perhaps especially for A&D. However, the 117th Congress ended without voting on the Facilitating American-Built Semiconductors (FABS) Act,⁹³ which would have added investment tax credits for US semiconductor manufacturers to the mix. Some of the FABS Act's provisions might, however, be revived in future legislation.



A convergent trend dating back to over a decade that has attracted renewed attention recently is the nearshoring of US (and Canadian) A&D components manufacturing to Mexico.⁹⁴ This long-term trend has seen explosive growth in recent years, fueled by the United States–Mexico–Canada Agreement (USMCA), which went into effect in July 2020 — NAFTA 2.0, in effect — and by pandemic supply chain disruptions, as well as the ongoing trade tensions with China. Nearshoring by US companies to Canada in the aerospace sector could also emerge as a growing trend, especially in the area of software development, a niche that Canadian federal and provincial government policy supports⁹⁵ and in which top Canadian firms⁹⁶ have considerable expertise.

US military spending in 2021 reached \$801 billion, a drop of 1.4% from 2020 (representing a slight decrease in GDP terms, from 3.7 to 3.5%).⁹⁷ Regarding prospects for aviation manufacturing investment, a perhaps more important trend in priorities at the Pentagon is a strong shift toward R&D. Between 2012 and 2021, US funding for military R&D rose by 24%, while arms procurement funding fell by 6.4%.⁹⁸ Convergently, while military R&D spending fell by just 1.2% in 2021 vs. 2020, arms procurement spending fell by 5.4%.⁹⁹ However, military suppliers in several states were buoyed by the release of the Air and Space forces combined budget proposal for FY2022, including \$156.3 billion for the Air Force and \$17.4 billion for the Space Force, reflecting increases of 3% and 13.1% over FY2021, respectively.¹⁰⁰ Budgetary priorities — likely to entail significant upsides for manufacturers in both cases — emphasize modernization of the Air Force and rapid evolution of the Space Force. The latter’s procurement budget, growing by \$456 million to acquire National Security Space Launch Vehicles for the anticipated launch of security and intelligence satellites, could prove especially stimulative to R&D innovation.

Canada

Canada holds its 2020 bronze medal this year, shooting up from 36th to 11th place for economy while ranking number one in labor for the third year in a row. With 5% of worldwide sales in aerospace (the province of Québec alone has 3%), Canada is among the globe’s largest A&D markets, ranking first in civil flight simulator production, third in civil engine production and fourth in civil aircraft production.¹⁰¹ Canada’s aerospace sector is strongly civil oriented (about 80% of production) and intensely active in R&D (five times more R&D intensive than the Canadian average for manufacturing).¹⁰² Montréal ranks third behind Seattle and Toulouse among world aerospace hubs and alone accounts for over 70% of Canadian aerospace R&D.¹⁰³ The MRO subsector, 41% of which is located in Western Canada, has grown 26% over the last decade to account for 31% of sector activity today (with the remaining 69% in manufacturing).¹⁰⁴

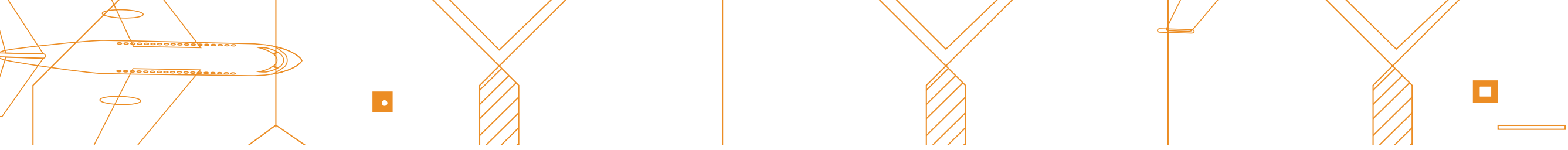
Aviation supply chains across the 49th parallel are tightly integrated in a relationship of mutual import-export: Canada sent nearly 57% of its A&D manufactures to the US in 2021, while about 60% of total sector exports arriving in Canada were American in 2019.¹⁰⁵ Multiple bilateral agreements favor US aerospace companies investing in Canada over other foreign markets, while ensuring that US and Canadian firms compete on a level playing across the continent. Major players include Bombardier, Bell Textron, Pratt & Whitney Canada, Safran, Goodrich, Boeing, GE, Rolls Royce and Lockheed Martin. Given the country’s vast landmass and thinly spread population, successful foreign investment typically relies on long-term relationships with local sales representation and/or bespoke distributorships.

While the pandemic disrupted Canada’s aerospace industry, it is now rebounding. Alberta’s Edmonton International announced in 2022 a proactive program to build infrastructure to accommodate hydrogen fuel aircraft by 2025 as part of a comprehensive ESG initiative, hoping to take the lead in stimulating demand for the green fuel (a win-win for the province, which currently produces 60% of Canada’s hydrogen).¹⁰⁶ On the other side of the country, Canada signed a “hydrogen alliance” with Germany in December 2022 to create a “transatlantic Canada-Germany supply corridor” by 2025.¹⁰⁷ The plan is to provide hydrogen and ammonia generated by wind power off the west coast of Newfoundland to help Germany to not only decarbonize its industries — and aviation specifically — but to reduce its dependency on Russian energy.

Approval of military spending in Canada is typically a protracted and politically fraught process. In 2010, for example, a Conservative government announced a CDN\$9-billion program to replace the country’s CF-18 fighter jets with US-made F-35s. Prime Minister Trudeau’s incoming Liberal administration canceled the still pending purchase in 2015, yet is now once again in discussion with Lockheed Martin to buy the jets.¹⁰⁸ Russia’s unprovoked invasion of Ukraine — and in particular Russia’s claimed use of hypersonic missiles¹⁰⁹ — has changed the budgetary calculus, with potentially significant consequences for defense aviation manufacturing in both countries. In June 2021, Canada announced the commitment of CDN\$5 billion over six years to comprehensively modernize the badly aging systems¹¹⁰ of the North American Aerospace Defense Command (NORAD).¹¹¹ The sole Canadian-American joint military program, NORAD was launched in 1958 to track and counter incoming nuclear-armed Soviet bombers and last upgraded four decades ago. The parameters of the upgrade are not yet clear, but it’s likely to involve an AI component for rapid incoming threat analysis. Some experts contend that NORAD should even be expanded to include Greenland if it is to effectively protect against not

only Russia but also Chinese and North Korean missiles.¹¹² Canada’s long-anticipated announcement in November of 2022 of a new Indo-Pacific strategy to confront Chinese military and cyber threats will also likely lead to increased military spending, though by exactly how much remains to be seen, since much of the committed USD\$1.7 billion will allocated to cyber security.¹¹³





United Kingdom

The UK climbs from its 2021 7th spot to 4th this year, with improvement in our metrics for economy (from 13th to 4rd) and cost (from 29th to 7th), owing in part to the pound's recent weakness. The UK's A&D industry is the world's second largest, after the US, and is intensely export-driven, despite not producing any large civil aircraft.¹¹⁴ In 2021, the UK's civil aerospace turnover amounted to \$32 billion, with 98% of production exported. Its defense industry turnover was \$33 billion, with nearly half exported, and its space industry turnover was \$22 billion, with \$8 billion exported.¹¹⁵

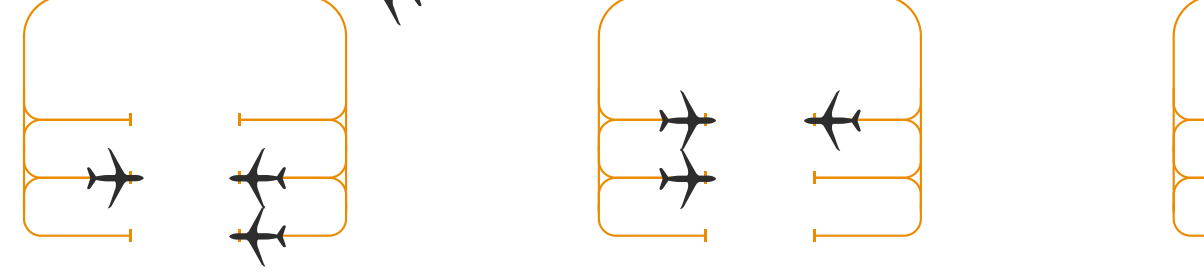
The UK's highly mature supply chain discourages new entrants unable to dedicate significant resources to break in. However, in the aftermath of Brexit, the UK is actively encouraging foreign investment, and acute and persistent backlogs for British Tier 2 A&D suppliers (and below) widen prospects for new market entrants to increase capacity and simplify local supply chains. Top R&D and manufacturing opportunities include aerodynamics, propulsion, structures and advanced systems (such as avionics), with an emphasis on advanced digital tools.¹¹⁶

More than 3,000 aerospace companies operate in the UK, providing nearly 300,000 jobs directly and indirectly.¹¹⁷ The UK is a global leader in R&D and manufacturing of engines, landing gear and wings — including the wings for all Airbus platforms, assembled in Broughton¹¹⁸ — and boasts a thriving MRO sector. Boeing's first European manufacturing site is in Sheffield¹¹⁹; while Rolls-Royce produces engines for more than 35 types of aircraft.¹²⁰ The UK also leads in helicopter manufacturing, dominated by Leonardo and an Airbus subsidiary.¹²¹ Some estimates foresee that drone-related business, both civil and military, could increase the UK's GDP by \$53 billion by 2023 and create up to 600,000 new jobs,¹²² offering major market opportunities for providers of related platforms, sensors and software. The growing space sector is especially

strong in small and nano-scale satellites, with seven new launch sites currently planned. Non-UK companies seeking local business relationships could consider the Harwell Space Cluster,¹²³ which hosts nearly 100 top space organizations, as well as the National Space Propulsion Test Facility, opened in 2021.¹²⁴

The government released an ambitious General Aviation Roadmap in 2021. This strategic infrastructure scheme seeks to expand capacity for manufacturing, MRO, aviation services and R&D across the country's network of local, regional and national/international airfields.¹²⁵ Investment opportunities could emerge for companies able to articulate specific projects that align with the Roadmap's broadly outlined goals, especially in the area of decarbonization and zero-emission aviation technologies, which are given priority.





Israel

Israel rockets to 5th place this year — its highest ranking ever, and up from 18th in 2021 — on the strength of significant growth in our metrics for cost, labor, industry and geopolitical risk.

Israel's defense-heavy A&D industry is the inverse of Canada's civil-dominated sector. Israeli defense spending averages \$15–18 billion annually.¹²⁶ The US provides Israel \$3.3 billion in Foreign Military Financing each year, and current US military aid to Israel (FY2019-28) is committed at \$33 billion.¹²⁷ The Israeli and American A&D industries are closely linked. In particular, Israel is a market for US-made components/subsystems, including in aerospace. Israel has ranked as the world's 10th-largest arms exporter for the last five years.¹²⁸ Israel's top weapons exports, at 20% of the total, are all aviation-related: missiles, rockets and air-defense systems.¹²⁹ Israeli companies also have leading expertise in space and airborne reconnaissance systems, radar, UAVs and avionics.¹³⁰

The most important recent development in the sector is a gigantic boost in Israeli weapons exports, which hit a record \$11.3 billion in 2021 (a 33% increase over 2020), largely as a result of the Abraham Accords.¹³¹

Israeli companies, including the parastatal (but publicly owned) Israel Aerospace Industries (IAI; one of the country's top-three defense firms)¹³² sold defense systems to Morocco, Bahrain and the UAE for \$800 million in 2021.¹³³ The surge in weapons sales underscores one of the strongest underlying motivations behind the treaties as well as their most significant effect to date. Israel's military contractors have benefited more from the Accords than any other economic sector of any of the countries involved.¹³⁴ The Israeli Ministry of Defense estimates that Israel's defense exports to Arab countries will surpass \$1 billion in 2022 (including IAI's sale of the Barak-8 surface-to-air missile system to Morocco for \$560 million, which will be counted toward 2022 export figures).¹³⁵ Moreover, in the wake of Russia's invasion of Ukraine, many European countries that have previously been reluctant to buy arms from Israel because of the situation in the Occupied Territories have dropped their objections. Europe is now the top regional purchaser of Israeli weapons systems (at 41% of Israeli defense exports). This factor in part accounts for another decisive change in the Israeli A&D industry: the surge in government-to-government transactions, which shot up from \$900 million to \$3.4 billion in 2022.¹³⁶



Notable events in other countries

Ireland

Ireland has landed 12th to 14th in our rankings in every year but one since 2014. This year's impressive rise to 6th place reflects improvements in metrics for cost (from 14th to 3rd place), labor (28th to 16th) and geopolitical risk (from 36th to 18th). This last figure likely reflects Ireland's relative political stability and economic resilience (compared to many other European nations and some members of NATO in current wartime-like conditions) and its favorable investment and trade climate (compared to uncertainties in the post-Brexit UK).

The world's aircraft leasing market was valued at some \$50.4 billion in 2021 and is expected to expand at a CAGR of 3.1% to reach about \$60.5 billion by 2027.¹³⁷ Ireland is the center of the industry,¹³⁸ hosting the global or regional headquarters¹³⁹ of most of the world's major aviation leasing companies,¹⁴⁰ including AerCap,¹⁴¹ the world leader, while accounting for about half of the global leased fleet.¹⁴² Aircraft Leasing Ireland, comprising C-suite executives from leasing companies doing business in the country, advocates for the industry with the Irish government.¹⁴³ One challenge to the industry is the confiscation — theft, effectively — of more than 400 leased aircraft by Russian operators since the invasion of Ukraine began (116 owned by AerCap alone). By mid-2022, Russian airlines had returned just a handful of leased jets.¹⁴⁴ However, the Kremlin announced a policy encouraging purchase of leased craft in September¹⁴⁵ — a plan that may not materialize so long as restrictions on financial operations with Russia imposed by the US and EU remain in place. While the insurance claims and litigation now underway¹⁴⁶ may take years to resolve, the long-term profitability of the leasing industry as a whole — and of leasing companies based in Ireland — is unlikely to be highly impacted.

Ireland's aerospace industry has emphasized MRO in recent years, with recent expansions by Panasonic Avionics and Dublin Aerospace,¹⁴⁷ as well as aviation software development.¹⁴⁸ As in Canada and the UK, local end-users strongly prefer international suppliers to have locally based partners/representatives. Aerospace product and parts manufacturing companies active in Ireland are highly diverse and mainly small to midsize players.¹⁴⁹

In February 2022, the republic's government published an in-depth review of the country's entire defense capability,¹⁵⁰ which led in turn to the approval of a High Level Action Plan¹⁵¹ that foresees Ireland's defense budget rising to €1.5 billion by 2028. The plan includes important upgrades to military radar capabilities and the purchase of new helicopters and long-range aircraft.¹⁵² These priorities could provide US defense technology suppliers, among others, with significant procurement opportunities over the next five years.





Spain

Among countries landing just below our top ten, Spain stands out for the biggest upward leap, to 13th place this year from last year's 26th. Even more notable are Spain's improvements in multiple metrics: in cost, from 42nd place in 2020 to 11th in 2021; in labor, from 40th to 26th; and in economy, from 73rd to 26th. In fact, Spain's showing this year reflects not only improvement in the sector's outlook in 2021-22 but at least a decade of steady growth.

The Spanish A&D industry overall has recovered impressively to very nearly its 2019 level and is now rated a best prospect sector by the US Department of Commerce, offering excellent opportunities for investment (local partnerships are typically crucial).¹⁵³ Spain's aerospace sector ranks 5th in Europe in terms of turnover and employment and 8th in turnover globally; rapid growth has been fueled by sustained investment in R&D, to which Spanish companies have dedicated more than 11% of turnover for a decade.¹⁵⁴ The industry is concentrated around Madrid and in Andalusia. Likely prospects for US and other firms in this market involve manufacturing of new aircraft and engines, as well as highly technical products such as composites, in which local industry has well-developed expertise.

The Spanish space industry is undergoing a shift from launches to satellite operations. Space centers in Spain include the European Space Astronomy Center, NASA's Madrid Deep Space Communication Complex and Boeing's European Center for Research and Technology; the country will launch its own Spanish Space Agency in 2023. The government has identified the aerospace sector as a strategic priority for to invest economic recovery, planning €4.5 billion by 2025 (with about 50% private-sector matching).¹⁵⁵ The government has also announced dramatic increases in military spending, in part to meet Spain's NATO commitments.¹⁵⁶

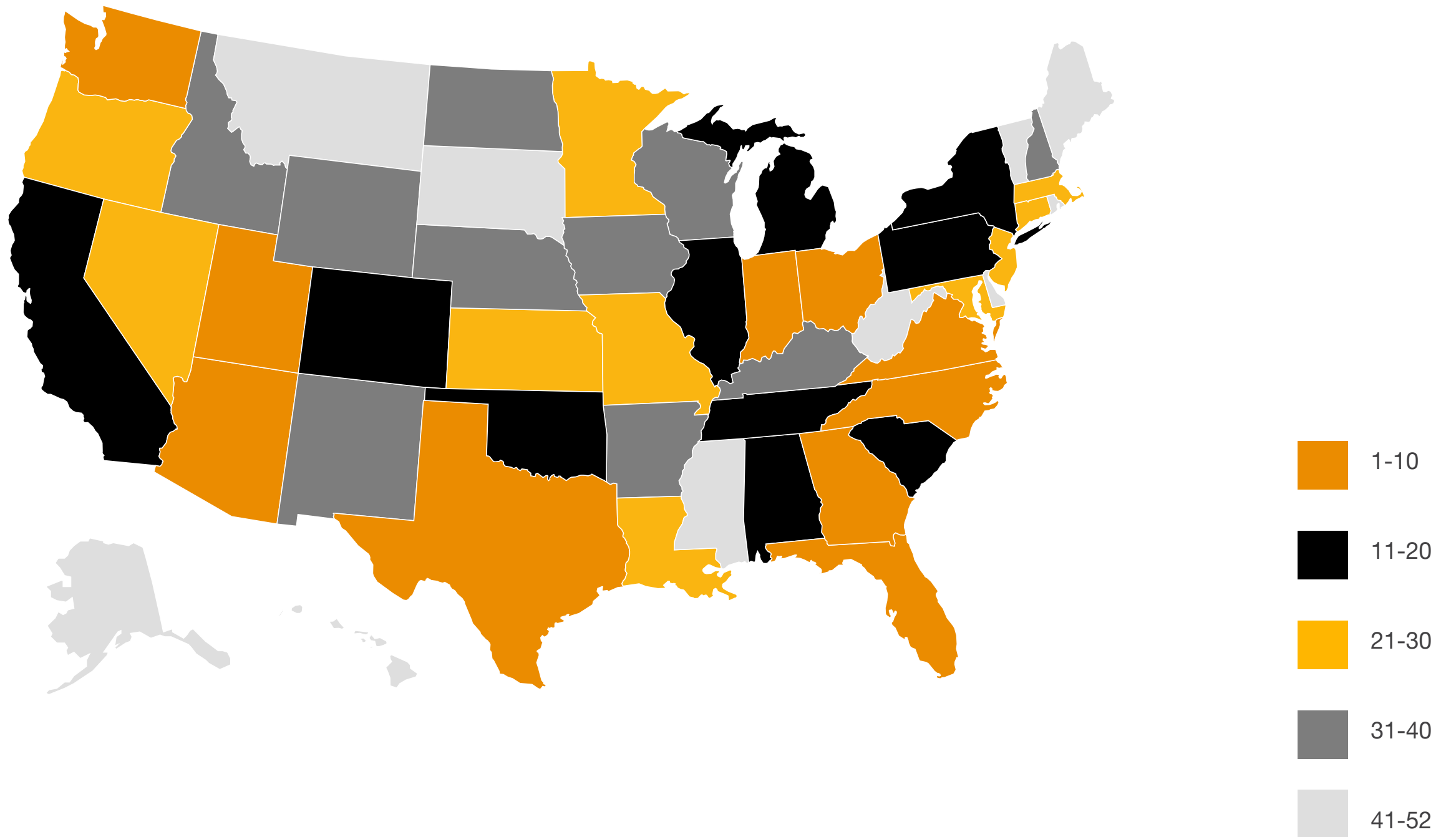


Considerations for your business

Our country rankings this year suggest a global aerospace industry in a state of flux. This comes as no surprise, given the complexity of doing business in the current phase of late-pandemic recovery. Across civil aviation, in both PAX and cargo, patterns of traffic and leasing remain shifting and unsettled. The sudden increase in military procurement triggered by the war in Ukraine, especially in the NATO countries, is also altering the global A&D picture. Despite current economic uncertainties, opportunities for successful investment abound in many markets.

The improved rankings for the UK, Israel, Ireland and Spain noted above provide particularly strong evidence of this changing landscape. So do other noteworthy shifts in our rankings: last year's top ten, for example, included countries that have fallen this year, with Japan sinking from 6th to 18th place and Switzerland from 9th to 12th. Our survey this year also shows that, while every sector of the global A&D industry is ever more globalized, securing the reliability, resiliency and transparency of manufacturers' supply networks has never been more critical. Strong collaborative relationships remain a key to success on a regional and global scale, as does support by investors of local training and education pipelines.

State rankings



Top 10 state rankings for aerospace attractiveness

Country/ region	Final Rank	Cost	Labor	Infrastructure	Industry	Economy	Tax Policy
Texas	1	28	8	13	2	1	1
Georgia	2	25	13	4	3	9	23
North Carolina	3	16	21	8	6	8	16
Ohio	4	36	32	4	4	10	7
Indiana	5	18	33	16	8	2	13
Arizona	6	17	10	13	5	21	15
Washington	7	49	3	16	7	16	1
Florida	8	37	23	9	9	5	14
Virginia	9	9	7	11	23	26	27
Utah	10	7	9	26	22	23	21

Let's take a closer look at notable industry initiatives or other indications of significant emerging or potential growth and opportunity among the five highest ranked states. This year's top-five states are perennial leaders. All ranked in last year's top ten, as all five have done since 2016.

In fact, our top-ten lists for 2020 and 2021 include the same states in an only slightly reshuffled order, with just two exceptions. Virginia notches up to 9th place this year from 11th in 2020, while last year's tenth-place Kansas drops to 21st place. A plunge in the sunflower state's infrastructure metric (down from 2nd to 25th place) largely accounts for Kansas's slide in our ratings. However, the launch in mid-2022 of the Kansas Infrastructure Hub could soon restore the state's strength on this score. The Hub is designed mainly to coordinate the efficient spending of some \$3.8 billion in federal funds via state agencies and local entities. It could be worth keeping an eye on.¹⁵⁷



Texas

Texas, never below the top four in our survey since its inception, holds its 2021 top spot this year, also coming in first, notably, in our metrics for economy and tax policy. The Texan A&D industry directly employs more than 138,000 Texan workers at more than 1,800 installations that represent 18 of the world's top 20 aerospace manufacturers. Texas ranks 3rd in the nation in aerospace product and part manufacturing firms and 2nd in exports (valued at \$8.43 billion in 2022). The state is home to 15 military bases, including six active Air Force bases and NASA's Lyndon B. Johnson Space Center. The state also has two FAA-licensed spaceports, the Houston Spaceport and the Midland International Air and Space Port. SpaceX maintains commercial launch sites in Boca Chica and McGregor, and Blue Origin launches space tourism flights from Van Horn. Texas-based firms are also pioneers in urban air mobility R&D.¹⁵⁸ The state's colleges and universities invest heavily in aviation-related R&D and are national leaders in sector workforce development. Among several recent labor force-related initiatives, one stands out: In October 2022, the US Department of Labor's North Texas Job Corps Center announced a new partnership with the US Aviation Academy, the North Texas Job Corps Airframe and Powerplant Mechanics Advanced Training Program, to fast-track aviation maintenance technicians' training (compressing 24 months of training into just 12) — addressing a pressing industry-wide need.¹⁵⁹ That could prove a model for other states to emulate.

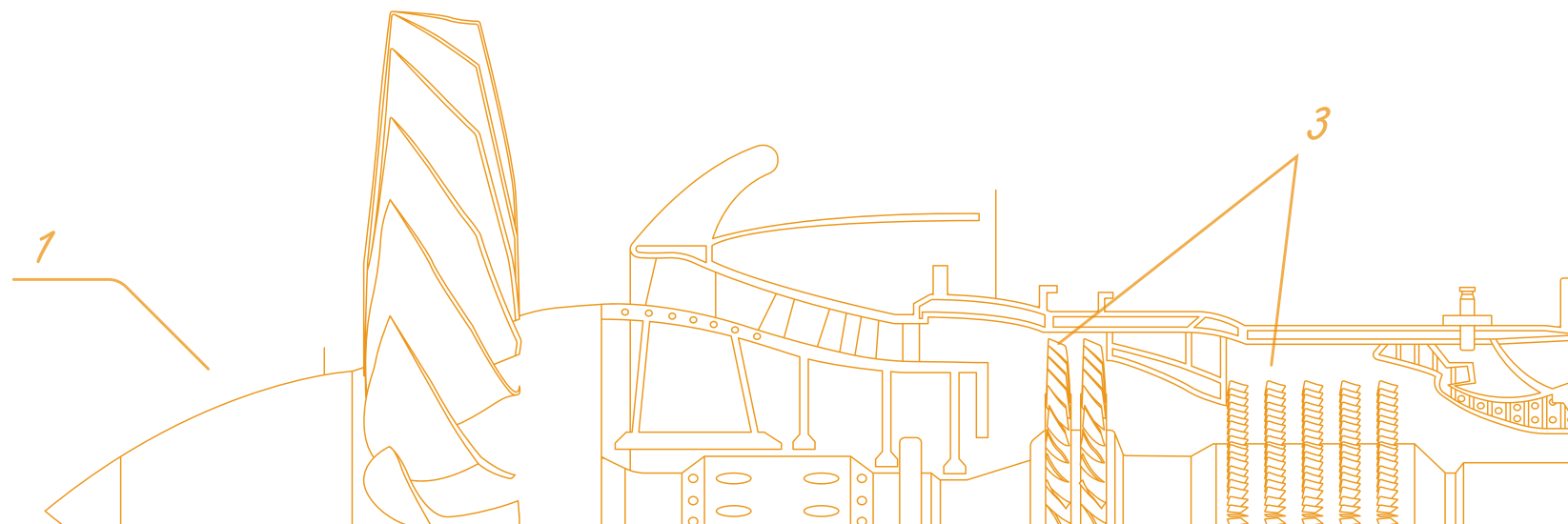


Georgia

Georgia, which has placed in the top four in our ranking since 2015, lands a strong 2nd this year. Aerospace products are the state's top export (\$9.19 billion in 2021) and its second-biggest manufacturing industry, with more than 800 companies and some 200,000 employees in aerospace-related industries generating \$57.5 billion in economic impact. Sector leaders active in the state include Lockheed Martin Aeronautics, Gulfstream Aerospace, Airbus, Hermeus, Pratt & Whitney and Universal Alloy Group, among others.¹⁶⁰ The Georgia Center of Innovation for Aerospace promotes collaborative business relationships to foster the state's growth in A&D.¹⁶¹ The state also has a robust aerospace education pipeline lead by Georgia Tech and reaching across several universities offering degrees in aerospace engineering and to five technical colleges with aviation programs, as well as a dozen high schools that offer training in the field. The state boasts many leading firms at the technological edge of aviation, including SpaceWorks, which is developing an array of solutions to the challenges of hypersonic and suborbital flight.¹⁶² The state also has advanced and growing capabilities in the area of unmanned systems (UAVs),¹⁶³ an area well poised to attract further investment. Archer Aviation Inc.¹⁶⁴ announced plans in late 2022 to locate an electric vertical take-off and landing (eVTOL) aircraft manufacturing facility in Covington, near the city's municipal airport. The site is expected to eventually create over 1,000 jobs and be capable of expanding to produce up to 2,300 aircraft annually, with production beginning in late 2024.¹⁶⁵

North Carolina

North Carolina, a top-ten finisher in our rankings in seven of the last eight years, reaches the number three spot this year, its best showing ever, with notable improvements in cost and infrastructure. Public investment led sector recovery and growth in 2022, with significant investment in two areas: infrastructure development at the state's 72 airports, and R&D in low-altitude civil drone applications and integration — an area in which the state has long been a national leader.¹⁶⁶ In January 2022, Boom Supersonic announced Piedmont Triad International Airport in Greensboro as the site for the Overture Superfactory, its first full-scale manufacturing facility.¹⁶⁷ The Superfactory expects to create 2,400 jobs by 2032 and to grow the state's economy by at least \$32.3 billion over 20 years. Boom will integrate workforce training by offering 200 internships through 2032 for students who attend publicly funded North Carolina universities, community colleges and technical schools. Also on track for 2022-23 is expansion of the state's hangar capacity for corporate aircraft¹⁶⁸ as well as a multi-business-partner program to develop the infrastructure and workforce needed to support growth in advanced air mobility market (including self-driving "flying cars" — aka passenger drones — and pilotless electric delivery aircraft).¹⁶⁹ Late 2022 saw two important ribbon cuttings: Summit Aviation's new parts manufacturing space in Greensboro¹⁷⁰ and Pratt & Whitney's turbine airfoil production unit in Asheville.¹⁷¹

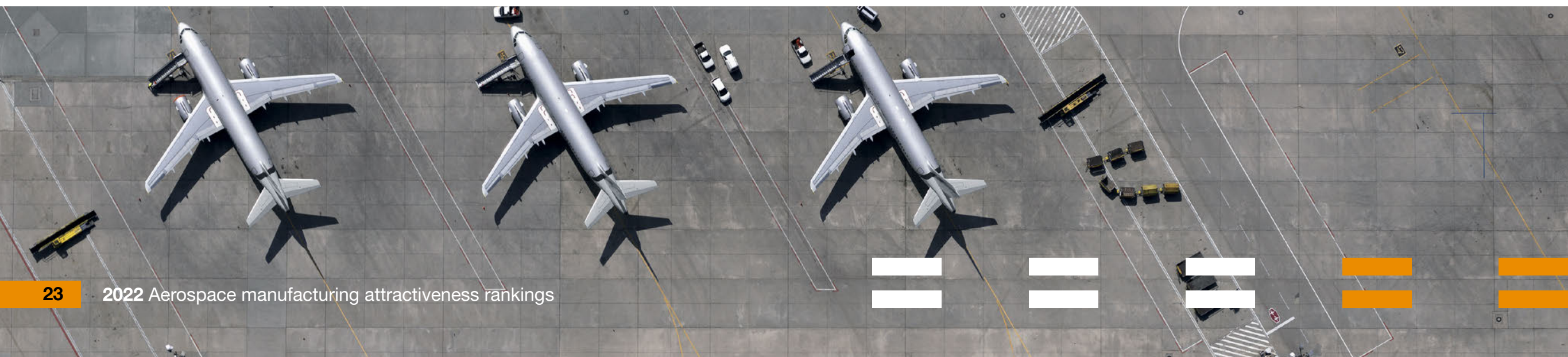


Ohio

Ohio, in the top nine in our survey since 2014 and the top three since 2016, slips slightly to 4th place this year, with a somewhat less robust showing on our labor, economy and tax policy metrics. Ohio's A&D sector¹⁷² encompasses some 550 aerospace companies, including OEMs and systems/components suppliers, employing about 37,000 people, and leads all states in supplying systems and parts to both Airbus and Boeing.¹⁷³ Other major players cover a wide spectrum of civil and military aviation, including GE Aviation, Eaton, Honeywell, the NASA Glenn Research Center (the agency's leading R&D facility), the Ohio Unmanned Aircraft Systems Center, Battelle Air Force Research Laboratory and Wright Patterson Air Force Base (the state's largest single-site employer). Ohio has recently developed particular strength in R&D and production capacity in UAV technology. Among the Ohio A&D employers who announced new hiring initiatives in 2022 were Hartzell Propeller,¹⁷⁴ Parker Hannifin, at its Gas Turbine Division Headquarters in Mentor,¹⁷⁵ and ZIN Technologies¹⁷⁶. Other 2022 news that reinforces the state's leading position in UAVs R&D included development of a new aircraft tracking system that could improve drone safety and of an unmanned system for training US fighter pilots.¹⁷⁷

Indiana

Indiana has cruised into a slot ranging from 5th to 8th place in each of the last seven years in our rankings and regains 5th place this year, where the state last landed in 2017. One major factor is improvement in cost — up to 18th from 28th place last year. Indiana's aerospace industry boasts an exceptionally high level of A&D export growth (nearly 29% on average since 2002)¹⁷⁸ and an impressive ratio of total economic output to workforce size.¹⁷⁹ The industry is relatively dispersed throughout all major urban areas across the state, and includes such pacesetters as Parker Aerospace, GE and Rolls-Royce, among many others.¹⁸⁰ As part of the state's recovery from the pandemic's acute phase, there has been some focus on clarifying multiple issues of property taxation affecting the state's 140-odd airports.¹⁸¹ As is also the case in other states leading in A&D, Indiana is also stressing workforce development and resiliency as the industry reemerges from the pandemic. The National Center for the Advancement of Aviation Act of 2021, passed in the state House in September 2022, would establish a private, tax-exempt organization to foster all aspects of aviation and aerospace education/training, promote sector employment (including support for military personnel seeking to transition to the civil sector) and aggregate economic and workplace safety data for the industry.¹⁸²



Notable events in other states

Alabama

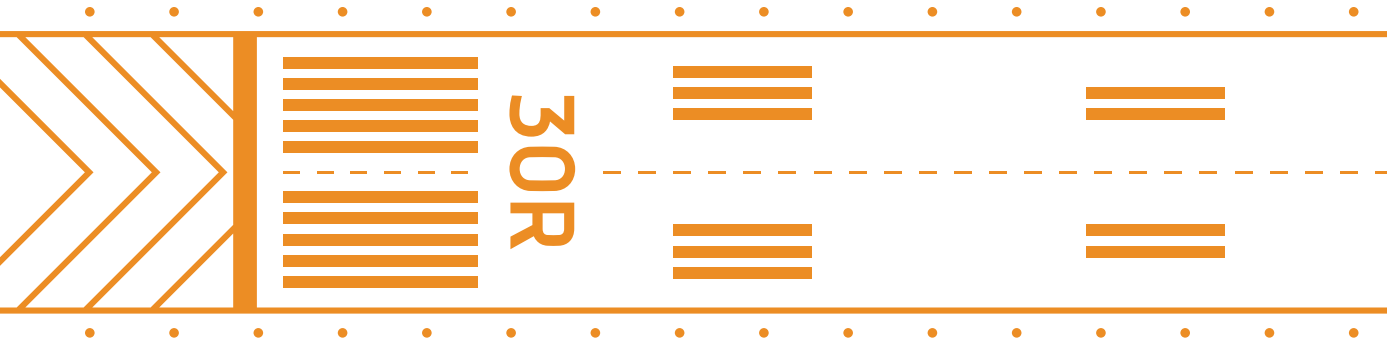
Alabama has landed at 11th to 13th place in our rankings in six of the last eight years and ranks 13th this year. The state’s A&D industry received a big boost in 2021 Q4 when Lockheed Martin inaugurated a 65,000-square-foot advanced hypersonic strike production facility in Courtland, where the company has maintained a manufacturing unit since 1994. The new facility will add 70 employees to the approximately 2,600 that Lockheed Martin already has in state.¹⁸³

Michigan

The Michigan Aerospace Manufacturers Association (MAMA) is developing the Michigan Launch Initiative (MLI), an ensemble of three sites founded on a public-private partnership model that together would constitute the Midwest’s first spaceport.¹⁸⁴ Separate vertical and horizontal launch sites would primarily focus on sending satellites into low-earth orbit, with a separate command-and-control center. The plan is controversial, however, partly owing to environmental concerns.¹⁸⁵ If the MLI is realized as currently conceived, it would have transformative effects on the space sector — in-state, regionally and even nationally — with revenues projected to reach about \$500 million by 2033.

Florida

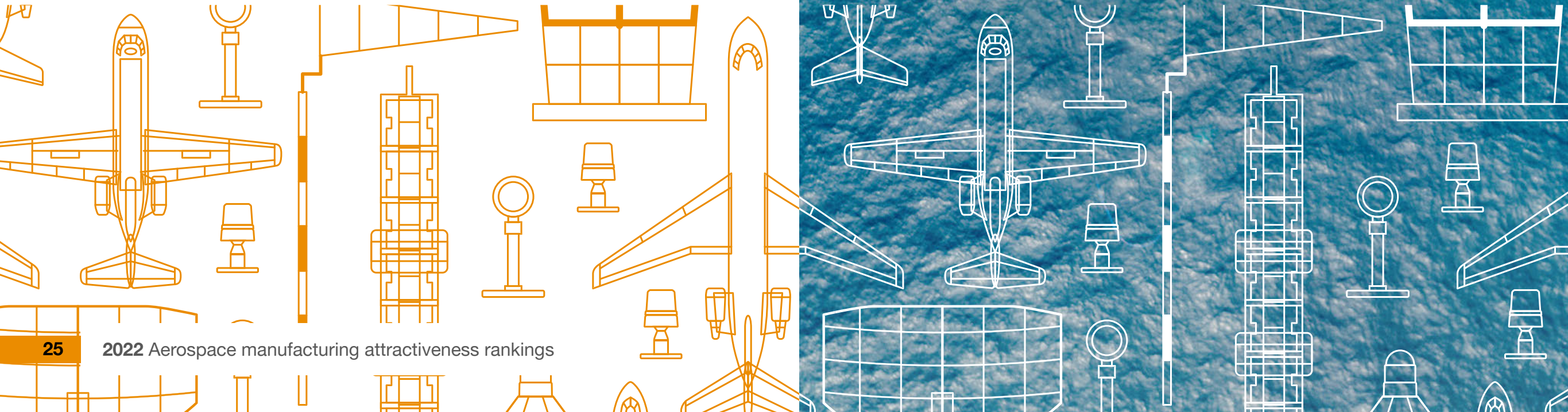
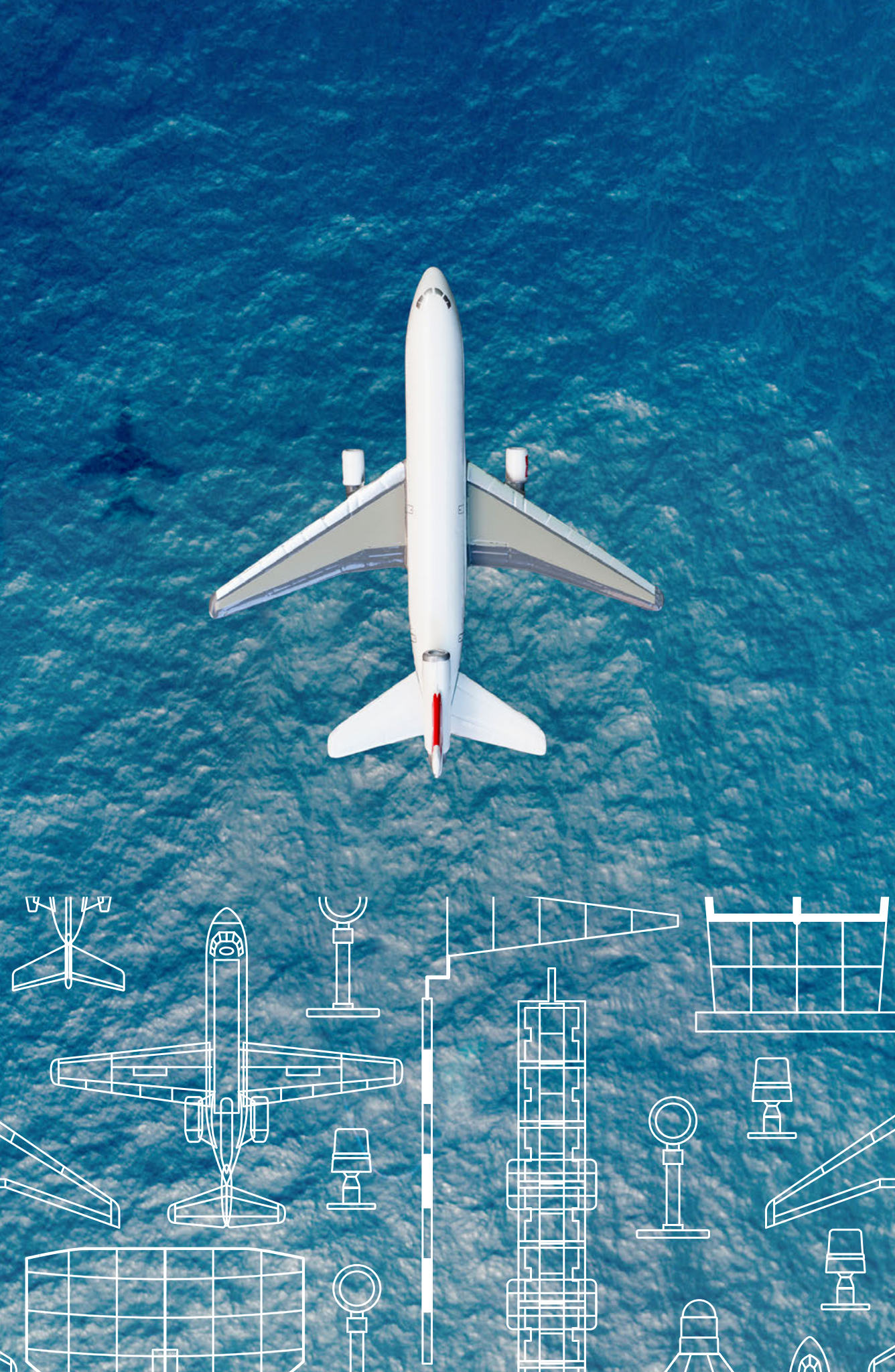
While the aerospace sector has been booming in Florida for many years, it has faced capacity challenges and stiff competition from other states. Space Florida, the state’s 16-year-old space agency, is aiming to grow the state’s skilled aerospace workforce with a multi-pronged effort.¹⁸⁶ In that context, Boca Raton-based Terran Orbital’s 2021 announcement of a \$300-million nanosatellite factory to produce up to 1,000 satellites annually was welcome.¹⁸⁷ As the first tenant of a 400-acre industrial park surrounding Cape Canaveral’s former space shuttle runway (unused since 2011), the site is expected to employ 2,100 people when it reaches full production in 2025. While Florida is well known for the diversity of its burgeoning A&D sector, the emphasis on workforce growth (as distinct from scale of investment or production) as a sector target is an interesting development — and one that other states might emulate.



Considerations for your business

This year’s state rankings emphasize the impressive resilience of US civil aviation manufacturing, despite the demand and supply-chain shocks of the COVID-19 era and the uncertainties of the current inflationary period. The need for workforce development — growth, diversification, education and (re-)training — and the efforts underway to address that need also emerge strongly as themes in many states.

States with well-developed supply networks to the US military, especially those that have invested in R&D capability enhancement in recent years, could expect strong growth in and beyond 2023. Competition among top states to attract space sector investment and green aviation startups reveals a growing emphasis on public-private collaborations and the development of new technologies that cross the boundaries among the civil, defense and space areas. Whereas innovation in past decades was often likely to cascade down into civil aviation from NASA and military R&D, today the reverse is just as plausible. Above all, the urgent priority to decarbonize all aspects of flight ensures that, while it is hard to predict which technologies will take the lead, the pace of change is likely to accelerate.



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