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Global aerospace and defense

Annual industry performance and outlook

2023 edition

— How are aerospace and defense companies worldwide performing today?
— What challenges and opportunities do they face?
— PwC takes a close look.

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Contents

Executive summary

The 2023 edition of PwC's Global Aerospace and Defense: Annual Industry Performance and Outlook shares key performance metrics of the global commercial aerospace and defense (A&D) industry. We collected our data from financial reports in fiscal year 2022 and included financial results for the largest 100 A&D companies by revenue (see the complete list in the appendices).

We also highlight notable industry developments and express PwC's point of view on topics affecting the industry now, which developed through interactions with our clients, other industry leaders, and analysts as well as a broad survey of current published opinion.

This year's report reveals key developments in recent trends, some of which were already evident to varying degrees in last year's report.

In **commercial passenger aviation**, this edition considers the robust late-pandemic rebound in demand for passenger travel and its ongoing challenges with a supply of available seats that remains restricted, mainly because of workforce shortages.

The story in **commercial cargo aviation** in 2022 had a slight decline in volumes and revenues due mainly to reduced consumer online shopping and a post-lockdown shift in demand from goods to services, as well as slightly restored passenger (pax) bellyhold space. The long-term prospects for air cargo growth remain very strong.

Russia's invasion of Ukraine stalled by late 2022 with the occupation of about 20% of Ukrainian territory. The ongoing war has profoundly affected the global military and civil aviation industries. The consequences for defense manufacturing and procurement are likely to prove transformational, with significant effects that may persist for decades.

US civilian and military A&D manufacturing face significant workforce transition challenges. Pandemic-exacerbated labor shortages are colliding with the prospect of workforce reduction. Up to 3.5 million vacancies are expected in the sector by 2026, 60% of which could remain unfilled.

The cost of addressing these issues might reach $49 billion.[1] While the A&D sector is somewhat insulated from changing consumer sentiment and the ups and downs of the business cycle, many A&D companies are feeling the pressures of pandemic-related supply-chain challenges, inflation and the possibility of a recession, all of which may increase challenges of workforce transition.

The nature of both work and the workforce have changed tremendously across the sector. Deft adaptation to emerging technology and cybersecurity demands, for example, are now as important as traditional manufacturing and engineering skills. Meanwhile, a once homogeneous workforce has evolved into a talent pool with up to four generations working side by side, each with its own career expectations.

A wave of retirement looms across skilled manufacturing over the next three to five years. Some studies predict that this changing of the guard could take the industry as long as two decades to digest.[2] Moreover, employee retention is a growing challenge. Overall turnover across the A&D industry, which is already confronting a tight labor market, rose to 7.1% in 2022 from 5.7% the prior year.[3] Effective knowledge management and succession planning are unavoidable priorities. To that end, it may be vital for many A&D firms to expand their ongoing digital transformation initiatives beyond such concerns as operational efficiency and supply chain transparency to encompass retirement and talent management.

Readers keen to focus on investment opportunities across A&D industries may find it useful to juxtapose this report's analysis with PwC's annual 2022 Aerospace manufacturing attractiveness rankings report, which provides data on — and insights into — top prospects for aviation investment among all US states and many countries worldwide. Likewise, our recent Future of the Industry: Predictions for the Global Space Sector webcast offers perspectives on emerging trends in the public and private space markets, areas at a critical inflection point.

Aerospace and defense

Overall, 2022 was a year of continuous recovery for the A&D industry in the wake of the pandemic. It was a year of increasing demand for “revenge travel” which spiking ticket prices did little to dampen. Revenue passenger kilometers (RPKs) increased by 64% in 2022 compared to 2021 but were still only 69% of 2019’s pre-pandemic record.

Meanwhile, many countries invested substantially in increasing their deterrence capabilities. However, as with commercial aviation, the defense industry suffered from supply chain disruptions caused by the pandemic and workforce shortages, resulting in similar constraints on production and margins.

The space sector is also experiencing heightened demand. Small satellite networks are proliferating, as the world moves toward a space-based economy. The industry is carrying out an accelerating pace of launches with several a week not uncommon. The space industry’s value is forecast to triple to about $1.5 trillion over the next decade.

Overview A&D performance 2022

The aerospace and defense industry reported revenues of $741 billion in 2022, just 3% higher than 2021, and $67 billion in operating profit, an increase of 8%. The modest improvement in revenue fell short of expectations as growing demand in end markets ran into production constraints due to supply chain and labor challenges. Industry performance remained below the pre-pandemic record levels. Industry revenues were 4% below the 2019 record of $780 billion, while industry operating profit was 18% below the 2018 record of $82 billion. These results, translated into US dollars, may slightly understate the strength of the recovery as the USD was about 12% higher against the euro and British pound in 2022 than in 2021, lowering the translated results of international companies.

Figure 1: Key industry metrics

	2022	2021	Change
Revenue	US$741 billion	$714b	3%
Operating profit	$67b	$62b	8%
Operating margin	9.1%	8.7%	40 bps

Source: PwC analysis

The commercial aftermarket leads a continuing industry recovery. The highest-performing companies in 2022 were generally those with significant commercial aftermarket exposure. GE Aerospace revenues increased by $4.7 billion (22%), the most for any company. Raytheon's Pratt & Whitney and Collins Aerospace segments' sales improved, in aggregate, by $4.2 billion (13%). Safran and Rolls-Royce improved their revenue by 28% and 21% respectively, in local currencies. Other companies with significant commercial aftermarket are Honeywell Aerospace, +7.3%; Howmet Aerospace, +13.9%; MTU Aero Engines, +13.2%; and TransDigm Group, +13.2%. OEM revenue also improved significantly. Boeing Commercial Airplanes revenue was up 33% on resumption of 737 MAX deliveries. Airbus commercial aircraft revenues were up 15%. Despite surging demand, overall industry revenue results (+3%) were less than expected because of production constraints caused by supply chain disruptions and labor shortages. Raytheon Technologies became the industry's largest company with $67 billion in revenue, surpassing Lockheed Martin, which reported a 1.6% dip.

Lockheed Martin remained the most profitable company despite an 8.5% decline, reporting $8.3 billion in profit. This performance was nearly 50% above that of the second-most profitable company, Airbus, with $5.6 billion in profits. GE Aerospace reported the best profit improvement — a 66% increase to $4.8 billion. Raytheon's Pratt & Whitney and Collins Aerospace segments reported an aggregate operating profit improvement of $1.2 billion, or 54%. However, profit declines in Raytheon's Missiles and Defense and Intelligence and Space segments reduced Raytheon's overall profit improvement to 9.2%. Rolls-Royce and Safran reported profit improvements of 46% and 30% respectively.

Overall, defense profits were down significantly despite strong demand in end markets. Boeing Defense, Space and Security reported a loss of $3.5 billion (-330%). Boeing's loss resulted from charges on multiple fixed-price development programs, including VC-25B, KC-46A, MQ-25, T-7A Red Hawk and Commercial Crew. Raytheon's Missiles and Defense and Intelligence and Space segments' aggregate profits were down by $976 million (-25%) owing to program mix and nonrecurring adjustments. Airbus Defence and Space reported a loss of $124 million. Lockheed Martin reported a profit decline of $775 million (-8.5%). Other defense companies reported modest improvements: General Dynamics, +1%; Northrop Grumman, +1%; Thales, +4%; and L3Harris, +2%. These results were due mostly to program performance issues. Furthermore, production and efficiency were constrained by supply chain and labor challenges.

Operating margins improve to 9.1%. Industry operating margin rose by 40 basis points from 8.7%.

Figure 2: Top 100 additions and deletions

Added to the list	
KBR Government Solutions	#30
Maximus	#36
Albany Engineered Composites	#97
Esco Aerospace & Defense	#100
Deleted from the list	
Mantech	Acquired
Meggitt	Acquired
Ultra Electronics	Acquired
Jamco	Performance

Source: PwC analysis

Figure 3: Analysis highlights

Largest increase in revenue (dollars)	GE Aerospace	+$4,740 million
Largest increase in revenue (percentage)	Vectrus	+62%
Largest increase in profit (dollars)	GE Aerospace	+$1,893m
Largest increase in profit (percentage)	CAE	+1,127%
Highest operating margin	Trimble	43.4%
Largest increase in top 100 list	Vectrus	+16
Largest decrease in revenue (dollars)	Leonardo	–$1,237 m
Largest decrease in revenue (percentage)	Kawasaki	–33%
Largest decrease in profit (dollars)	Lockheed Martin	–$775 m
Largest decrease in profit (percentage)	Magellan	–408%
Largest decrease in top 100 list	Mitsubishi	-15

Source: PwC analysis

Figure 4: Companies with operating margins exceeding 20% increased from 10 to 12:

Top 100 rank	Company	Operating margin
15	Honeywell Aerospace	27.3%
29	TransDigm	40.8%
40	Trimble	43.4%
42	Hindustan	21.2%
43	Eaton Aerospace	23.2%
53	Heico	22.5%
56	Aselsan	34.3%
59	Bharat Electronics	20.6%
74	Teledyne	21.1%
76	Exchange Income Corporation	20.4%
83	Garmin	36.1%
99	Larsen & Toubro	26.9%

Source: PwC analysis

A&D deals

A slow year — with a few surprises

In late 2022, A&D sector dealmaking activity hit its lowest point since 2019. Nonetheless, deals in commercial aerospace parts manufacturing and maintenance, repair and operation (MRO) continued steadily. Supply chain challenges persisted through 2022. While nettlesome for many companies, these challenges may also present opportunities for strategic acquisitions.

Overall, the defense aviation M&A picture was focused on small portfolio-oriented transactions rather than platform investments or large-scale deals. Defense deal volumes and values were affected by the US Department of Defense's adoption of measures against further large-scale consolidation in the defense industrial base to reduce perceived risks to national security.[4] Bright spots for deals remain in such areas as space, cybersecurity, hypersonic flight, unmanned aerial vehicles (UAVs, aka drones) and other DoD budget-priority sectors.

For further details and analysis, consult PwC's Aerospace and defense: US deals 2023 outlook.

Notable 2022, early 2023 deals:

— **L3Harris stands out in a lackluster year**. In December 2022, L3Harris moved to acquire Aerojet Rocketdyne — the last independent manufacturer of missile propulsion systems in the US — for $4.7 billion. The deal is still under review by the FTC but is expected to close by end 2023. At the same time, L3Harris successfully spun off its Visual Information Solutions commercial geospatial technology and software business.[5] In early 2023, L3Harris also made a deal to buy ViaSat's defense communications data business.

— **JetBlue's attempted acquisition of Spirit** — the biggest US airline deal on the horizon — suffered yet another setback as the Department of Justice sued in March 2023 to block the deal.[6] The merger, approved by Spirit shareholders in October 2022 in the aftermath of a protracted bidding war between JetBlue and Frontier once again faces an uncertain outcome. The deal also remains subject to a Department of Transportation (DoT) action to determine whether it is in the public interest, a process that the DoT has only paused pending the outcome of the DoJ antitrust suit.[7]

  If successful, JetBlue's $3.8 billion all-cash bid for Spirit would create the country's fifth-largest airline, commanding some 10% of the US pax market (double JetBlue's current level).

— **In October 2022, Amazon.com sought to acquire as much as 15% of the outstanding shares of Hawaiian Holdings**, the parent company of Hawaiian Airlines. The deal could serve to expand Amazon's cargo operations using a fleet of leased Airbus SE freighters (initially just 10 planes with options for more) that Hawaiian will operate for Amazon, upping the ante in the e-commerce behemoth's rising challenge to UPS and FedEx in the US cargo-hauling space. For Hawaiian, the deal offers a welcome source of income as the cross-Pacific pax travel between the US and Asia, on which the airline relies, rebounds more slowly than some other markets.

— **The low-cost Canadian carrier Flair Airlines was in talks to go public in early 2023** via a merger with SPAC New Vista Acquisition Corp. Since Canadian law does not permit foreign investor control of airlines, Flair was compelled to restructure to reduce New Vista's degree of control. New Vista has been looking for prospects since raising US$276 million in February 2021.[8]

Commercial aviation and aerospace

Key takeaways

- Surging pax demand despite higher airline ticket prices
- RPKs recover to **77%** of pre-pandemic levels by year end in 2022
- A flood of new aircraft orders at Boeing and Airbus: **1,594** in total
- 737 MAX deliveries resume
- Airbus' deliveries increase by **9%**, Boeing's by **41%**
- The super-jumbo era sunsets
- Supply chain disruptions and labor shortages constrain recovery

Orders are up at Boeing and Airbus, with a near-record backlog. Airbus delivered 661 aircraft in 2022, a 9% increase over 2021 but 23% below the company's peak production of 863 in 2019. Boeing delivered 480 aircraft, a 41% increase over 2021 as 737 MAX deliveries resumed but still 40% below 2018's record production of 806. Airbus reported 820 net orders in 2022, while Boeing reported 774, pushing total backlog toward the record level of 12,888 set at the end of 2019. Industry backlog of $720 billion and nearly 12,000 units is more than seven years' worth of production at record-production levels.

Figure 5: Aircraft backlog (US$ billions)

	12/31/22	12/31/21	12/31/20	12/31/19
Boeing	$330	$297	$282	$377
Airbus	$390	$345	$325	$475

Source: The Boeing Co. 2020 annual report; Airbus Group 2020 annual report

Figure 6: Aircraft backlog (units)

Index	Boeing	Airbus	Total
Net orders	774	820	1,594
Deliveries	480	661	1,141
Backlog at Dec. 31, 2021	4,578	7,239	11,817

Source: The Boeing Co. 2020 annual report; Airbus Group 2020 annual report

Global pax RPKs rose while cargo volume contracted. For 2022, the International Air Transport Association (IATA) reports that RPKs reached 68.5% of pre-pandemic levels and recovered still further to 77% by December.[9] China, the world's biggest aviation market, announced in March 2023 that it would begin to loosen restrictions on commercial aviation and fully reopen its borders to foreign travelers. The cargo market contracted for the year, including the last ten consecutive months. This was due to multiple factors, including the partial easing of supply chain disruptions, increasing fuel costs and a softening economy.

Figure 7: Key commercial aerospace metrics (year-over-year % change)

	2022	2021	2020	2019
Revenue passenger kilometers (RPKs)	–31%*	-58%*	-66%*	4.2%
Load factor	65.1%	74.3%	64.8%	82.6%
Cargo tonne-kilometers (CPKs)	-8.2%	18.7%	-10.6%	-3.3%
Load	50%**	53.8%	54.5%	43.4%

* Compared to 2019

** 2022 monthly average[10]

Overview

Commercial aviation and aerospace performance 2022

Overall, the global commercial aviation and aerospace industries strove throughout 2022 to respond to an economy drastically altered by war in Europe and to ongoing supply chain and labor force challenges stemming from or exacerbated by the pandemic.

US A&D exports continued to recover in 2021-22. Between 2019 and 2020, US A&D exports dropped by $57.4 billion, or 39%, from $147.4 billion to $90 billion. The pandemic's impact cannot be overstated.[11] Since then, US A&D exports have partially recovered, rising by 11.2% between 2020 and 2021 to a total value of $100.4 billion (in a 65% or 35% ratio of civil to defense aviation). While US A&D exports went to 205 countries in 2021, the leading export destinations were France, Canada, Brazil, the UK and Singapore.[12] Monthly US civil aircraft, engines and parts exports figures for 2022 suggest that the recovery continues, and that the final 2022 figures could be about 50% above 2021 for the civil sector.[13]

International travel restrictions eased yet remain complex and dynamic. In the US, the Centers for Disease Control order requiring proof of vaccination remains in effect for noncitizen nonimmigrants (i.e., visitors).[14] Mask-wearing has been optional on most major airlines within the US since April 2022.[15] With China lifting the travel restrictions beginning in March 2023, residents of overseas Chinese communities are particularly eager to visit. Hong Kong's government got ahead of the policy change, announcing in February plans to give away 500,000 free airline tickets to revive its tourism industry. However, while the current paucity of direct flights to and from China and high prices may suppress leisure travel, signs indicate that business travel is likely to surge.[16]

Entry rules continue to vary across the EU/EEA, as some have abolished COVID-19 measures altogether while others continue to impose less stringent restrictions for some categories of travelers.[17]

Commercial passenger aviation in 2022 continued its 2021 recovery. With fears of infection abating, travel demand recovery beginning in late 2021 and throughout 2022 brought a surge in large domestic markets such as the US, Brazil and China, while long-haul international travel — both business and leisure — remained somewhat slack.

- **Total global 2022 pax traffic** (measured in revenue passenger kilometers, or RPKs) rose 64.4% compared to 2021. Full-year 2022 global traffic was at 68.5% of pre-pandemic (2019) levels.[18]
- **International traffic in 2022** skyrocketed 152.7% over 2021 and reached 62.2% of 2019 levels.[19]
- By contrast, **US domestic traffic for 2022** rose just 10.9% compared to 2021[20] (this reflects the fact that US 2021 air travel was punctuated by impressive domestic holiday travel surges). US 2022 domestic traffic was at 79.6% of the full year 2019 level.[21]
- In the US, **overall pax capacity**, like pax traffic, has not fully recovered. The number of total airline seats available sits around 18% below the 2019 level.[22] With the drop in number of passengers roughly equaling the reduction in capacity, planes are flying full.
- Among **global regional markets**, Asian-Pacific airlines boasted the strongest year-over-year recovery with an impressive 363.3% rise in full-year international 2022 traffic over 2021.[23]

In most markets around the world, domestic demand recovery is expected to be restored by sometime in late 2023 or early 2024.[24] International travel demand is now expected to recover to 2019 levels by 2025.[25]

US pax demand was strong despite intermittent airport chaos. Flight cancellations among major US airlines increased by 69% in 2022 — a huge rise, considering that scheduled flights increased by only 13%. Nearly 60% of the cancellations occurred between January and June, with conditions improving in the second half of 2022. The data for flight delays and lost luggage are comparable.[26] US consumer complaints about airline service have risen by 300% from prepandemic levels.[27] Nonetheless, two US airlines made AirHelp's 2022 top ten list of the world's best airlines.

Russian civil aviation is in dire straits. A crisis predicted since the war's onset appears to be imminent. As sanctions start to occur, Russia has limited access to parts, software and technical skills necessary for critical MRO on hundreds of commercial jets, raising safety concerns across the industry.[28]

Airlines leverage pricing power. US domestic average itinerary airfares surged in 2022 by 33.4% over 2021,[29] but travelers weren't put off. Online spending for US domestic flights, for example, rose to $8.8 billion in March 2022, 28% higher than its comparable prepandemic level.[30]

Current fares, however, are not historically high. In inflation-adjusted 2022 constant dollars, 2022 fares were in fact lower than fares in every year from 1995 through 2019.[31] The 2022 revenge-travel price hike may prove to be as much a transient phenomenon as the pandemic-driven 2020-21 price drop.

Ability and willingness to pay higher fares may wane. Federal stimulus checks and reduced discretionary consumer spending enabled Americans to stockpile $2.1 trillion in "excess" savings (i.e., savings above customary levels), which likely sparked the 2022 travel boom.[32] But by March 2023, excess savings had fallen to about $900 billion, with a return to the US savings status quo predicted by the end of 2023.[33] A steep rise in credit card debt in 2022 also indicates that air travel spending at a 2022 pace may be unsustainable.[34] Before 2023 is out, airlines may feel squeezed between the pincers of rebalancing supply and demand in the pax market if both pent-up demand and discretionary spending capacity fade.[35]

Russia's invasion of Ukraine sent jet fuel prices skyrocketing to their highest level since 2008.[36] The price of jet fuel, which in recent years has closely tracked that of Brent crude, appears to be decoupling from this key indicator, spiking above Brent by as much as 65% since January 2022.[37] A pandemic-inspired shift in consumer purchasing behavior toward ticket buying closer to departure date has, however, enabled airlines to pass on part of increased fuel costs much more quickly than they could do in the past.[38]

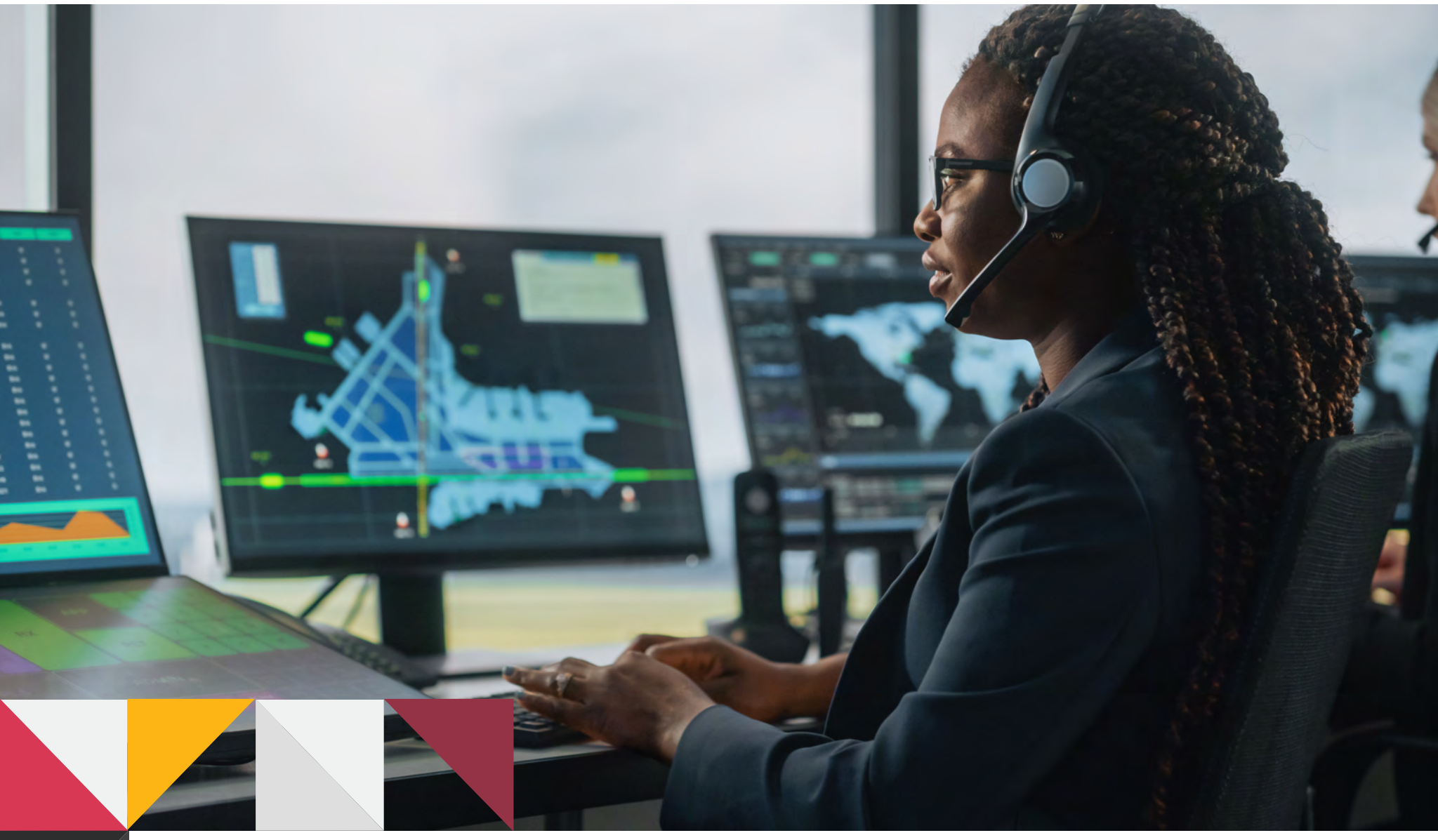
A double whammy: Supply chain and labor market challenges. Parts shortages disrupted pax travel in mid-2022, compounding airlines' ongoing staffing shortages. While A&D manufacturing infrastructure has largely survived the 2020-21 pandemic demand shock intact, component and assembly providers below the OEM and Tier 1 levels are facing a liquidity crunch that may inhibit a smooth return to 2019 production levels.[39] The industry-wide long-term reduction of the ratio of employees to passengers is partly responsible, as is the steep rise in understaffing due to illness caused by late COVID-19.[40] Travel demand surges continue to clash with capacity constraints in some key markets caused by persistent shortages in support functions such as security screeners and ground crew.[41]

Shortage of highly skilled aviation engineers also intensified in 2021-22, as many had left the field for other industries.[42] Indeed, concerns surrounding an engineer shortage have existed for more than a decade.[43] Concerted long-term investment in education and training is needed to resolve this problem, which appears to be even more severe than the pilot shortage.[44]

To attract and retain pilots, airlines will likely need to pay up. An agreement between Delta and its pilots' union, ratified in March 2023, will increase salaries by 34% over three years and includes a raft of enhanced benefits amounting to some $7 billion in cumulative increases through December 2026.[45] Three other major US airlines were negotiating new contracts with their unions as of March 2023.

Commercial business travel remains suppressed. By fall 2022, US domestic business travel had reached about two-thirds of its prepandemic level, while international business travel remained at about half.[46] Business travel prospects for 2023 remain highly uncertain as companies cut back on expenses and brace for inflationary headwinds.

American air traffic control is in dire need of investment to improve efficiency and safety. The head of the NTSB announced in March 2023 that "close calls"[47] are on the rise.[48] A 90-minute suspension of US departures on January 11, 2023 was just one of many recent incidents to reveal vulnerabilities in air traffic control IT, some of which dates back to the 1970s.[49] Funding may prove less a barrier to improvement than attracting the needed technical talent.



Notable developments and outlook

The trajectories of pax and air cargo continued to diverge in 2022, as they have since the pandemic's onset.

PASSENGER AVIATION

"Bleisure" (or blended) travel was the talk of the industry in late 2022.[50] The pandemic-fueled spike in remote and hybrid work is being mirrored in air passengers' itineraries, as more business travelers extend their trips for leisure pursuits. American Airlines estimates that nearly 50% of its 2022 revenue results from blended travel, up from a pre-pandemic level of 25%.[51] One looming question in the industry: How nimbly and surefootedly can airlines pivot to offer pricing that encourages and accommodates the extended-weekend itineraries bleisure travelers want?

Boeing and Airbus orders and deliveries rebound. Like 2021, 2022 was a year of recovery for civil aviation manufacturers after the 2020 plunge that interrupted a decade of inexorable growth. Still, supply chain fragility and constrained labor markets 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.[52] With 663 aircraft delivered, Airbus edged out Boeing (with 480) in deliveries for the fourth consecutive year.[53] Airbus also surpassed Boeing in net orders by a margin of 6%.[54] Airbus is likely to continue to lead in deliveries in the near to medium term, given its deeper backlog.[55] By the end of October 2022, Airbus had reported a backlog of 7,397 jets, while Boeing's backlog was 5,323 aircraft.[56]

Among new orders, two highlights stand out, both at Boeing.

- With issues stemming from the 2018 and 2019 Max 8 crashes largely resolved,[57] Delta announced in July 2022 an order for 100 Max 10s 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.[58] In January 2023, Boeing announced the addition of a new 737 Max production line in Everett, Washington, to boost output.[59]

- Boeing also received a boost 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.[60]

In April, **Airbus agreed to double its production in China**. China's air traffic is forecast to grow much faster than that in other world markets over the next two decades, with the Chinese market expected to reach 20% of global demand for new aircrafts.[61]

Corporate private jet purchases surged in 2022 as spending in the sector reached a ten-year high.[62] Monthly private flights are up in the US by 30% from pre-pandemic levels, and private jets now account for a quarter of US flights, double their 2019 level (of course, not all private flights are for business).[63] The global business jet market is on track to continue a steady increase from $24.21 billion in 2020 to $28.64 billion in 2023 and a projected $36.94 billion in 2028.[64] That signals good news for the world's largest producers of these jets, including Bombardier, Embraer, Gulfstream, and others. Whether this represents a long-term shift away from commercial flights to company-owned or rented planes remains to be seen.

Russia's expropriation of leased aircraft remains unresolved but will likely have limited long-term effects on the commercial aircraft leasing industry. The confiscation of more than 400 leased aircraft by Russian operators since the invasion of Ukraine began continues to trouble lessors. In September 2022, the Kremlin announced a policy encouraging purchase of leased crafts.[65] While the insurance claims and litigation now underway[66] may take many years to resolve, the long-term profitability of the leasing industry is unlikely to be reduced. The world's aircraft leasing market was valued at some $50.4 billion in 2021 and is currently expected to expand at a CAGR of 3.1% to reach about $60.5 billion by 2027.[67]

US airlines, banned by Russia since the beginning of the war from flying polar routes through Russian airspace, are lobbying Congress for relief. The industry group Airlines for America estimates US carriers' total lost annual market share at $2 billion annually. The organization has petitioned the Biden administration to forbid foreign carriers, still permitted to overfly Russia, from all access to US airports. The campaign remained unresolved at the time of the writing of this report.

Since the COVID-19 outbreak, at least 64 airlines have ceased to operate, most driven out of business by the pandemic lockdown cashflow crunch (31 in 2020, 19 in 2021, and 12 in 2022). It's important to note that 34 airlines went bust in 2019, the last pre-pandemic year.[68] In the rearview, pandemic pax carrier bankruptcies appear to be linked to a long-term industry consolidation trend, with perhaps some exacerbation of the common churn in budget airlines, especially in Europe.

The US pax regional carrier market remains challenging even for the biggest airlines. United, American, and Delta have all cut regional routes since COVID-19's outbreak, while United and American have been forced to ground up to a hundred of their regional jets for lack of pilots to fly them.[69] The biggest hubs can squeeze even a big player out: United ended its service at JFK in October 2023.[70] Many airlines are feeling the need to trim pre-pandemic plans for route network growth to major markets to improve reliability on routes they are in some cases struggling to maintain.

By spring 2023, American, Delta and United had collectively dropped 74 regional/local airports from their networks.[71] Meanwhile, to judge by Delta's and United's announced plans to restore international routes in summer 2023 (some of which had been suspended during the pandemic),[72] it may be easier for big carriers to expand international rather than domestic routes.

Improvements at some major US airports are afoot. Airports leading the way include LaGuardia, Newark, Orlando International, Kansas City International, and Detroit Metropolitan.[73] For instance, Delta is investing $1.5 billion to upgrade its facilities at JFK, which it has consolidated in Terminal 4, with a focus on enhancing passenger experience and growing its cargo capacity.[74]

Meanwhile, the Biden administration announced nearly $1 billion in airport funding under the Bipartisan Infrastructure Law to 99 airports nationwide, targeting the upgrading of terminal facilities, security screening, baggage handling systems, local transportation access, air traffic control and sustainability.[75]

2023 opened with a significant event: The delivery of the last Boeing 747.[76] While some may argue that the aircraft has been effectively obsolete for decades,[77] the erstwhile "Queen of Skies" epitomized the postwar revolution in middle-class consumer travel for half a century.

Light painting for fuel saving? A team of researchers at the University of Central Florida has invented a proof-of-concept paint that could offer game-changing potential to the aviation industry.[78] The first paint to be based on structural color, the coating uses aluminum nanoparticles to create color without pigment and could reduce weight and therefore fuel costs — an airline's biggest operating expense at about 30%. Painting a Boeing 747 with structural paint would add just 1.3kg, compared to 500kg with conventional paint.[79]

Push for net-zero 2050. In October, 2022 member states and organizations of the International Civil Aviation Organization adopted a long-term global aspirational goal of net-zero carbon emissions by 2050. Achieving the target will entail continued multiple carbon emissions reduction measures, including accelerated development and adoption of innovative aircraft technologies, streamlined flight operations, and a rise in the production and deployment of sustainable aviation fuels (SAF).[80]

CARGO

While air cargo declined slightly in 2022, long-term prospects still appear bright. Global air cargo was off overall in 2022 beginning in March[81] after outperforming pax traffic from the pandemic's 2020 outbreak throughout 2021 (and providing a critical cash flow lifeline to many passenger airlines) with 18 months of record-setting volumes and revenues.[82] Lower cargo volumes were due mainly to reduced consumer online shopping and a post-lockdown shift from goods to services as well as partially restored pax bellyhold space. Meanwhile, demand for main-deck cargo jet conversions continued to soar through 2022.[83]

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 2022 for the first time following widespread protests. Nonetheless, long-term growth prospects for the air cargo industry look promising. Boeing forecasts global cargo traffic to double over the next two decades, increasing the world's cargo jet fleet by 60%, to more than 3,600 jets (with two-thirds of the fleet being conversions).[84] Small to medium size cargo craft will likely also continue to undergo technological experimentation and innovation to develop greener fleets.

The world's largest airplane may rise again. Mriya, a mammoth cargo jet designed and built in Ukraine in the 1980s — the world's largest aircraft — was largely destroyed by shrapnel on the first day of the Russian invasion.[85] Mriya's reconstruction was begun in spring 2023 with the salvage of reusable parts from the wreckage, which the owner, Antonov, a state-owned enterprise, intends to fit to the existing fuselage of a never-completed twin.[86]

DRONES

Commercial UAV adoption has progressed rapidly in agriculture applications such as crop monitoring, assessment of soil dryness, precision spraying and livestock monitoring. The US market is dominated by Chinese manufacturers; whether the Treasury Department's December 2021 sanctioning of drone maker DJI (which commanded 80% of the US consumer drone market share in 2020) will have much practical effect remains to be seen.[87]

A new era of heavy-lifting drones? Drones capable of heavy lifting would exceed the FAA's 55-pound limit for small UAVs. Such craft could, however, save time and money — and lives — in diverse civil and private-sector applications now conducted by crewed helicopters. Among the most important could be wildfire suppression: drone delivery of hose coils alone could be a game-changer. The US drone ecosystem could benefit from greater collaboration between the private and public sectors. Major American civilian airports, for example, have barely begun to prepare to build UAV infrastructure. Current restrictions on drone use of airspace[88] will likely need to adapt to advancing applications (e.g., minerals scouting, water scouting and pipeline inspection, as well as mothership drones that release and recuperate smaller UAVs).

SPACE

California-based Relativity Space was forced to call off the launch of the world's first 3D-printed rocket on March 8, 2023, for undisclosed reasons. If a rescheduled launch ultimately proves successful, it would be the first methane-fueled rocket to achieve orbit.[89]

In April 2022, Amazon signed a deal with Blue Origin, United Launch Alliance (ULA) and Arianespace for up to 83 launches of its Project Kuiper internet satellites. The contract is part of the company's ambitious plan to send a network of 3,236 satellites into low Earth orbit to provide high-speed internet service everywhere on the planet, authorized by the FCC in 2020.[90]

Led by this activity in internet satellite service, **the commercial space sector is forecast to triple over the next decade to $1.4 trillion**.[91] The growing "space-for-earth" economy of services produced in space for terrestrial use is building the foundation for breakthroughs to a long-anticipated space-for-space economy.[92] In March 2022, NASA reopened competition to find a second company to back up the Artemis program, giving Blue Origin a second shot after losing out to SpaceX before.[93] Given the scope of NASA's current plans — ten crewed missions to the Moon, a permanent Moon space base and ultimately a crewed mission to Mars — the American space sector is likely to see many more such public-private collaborations in coming years.[94]

Northrop Grumman announced in August 2022 that it would replace Russian engines on the rocket that carries NASA cargo to the International Space Station with American-made units. The missions will initially use SpaceX's Falcon 9 rockets on an interim basis, then move to engines that Firefly Aerospace has been developing for a new version of the Antares rocket in late 2024.[95]

In November 2022, **SpaceX** launched its largest rocket, the Falcon Heavy, for the first time in three years, bearing a classified payload into orbit for the US Space Force, a sign of increasing reliance by the Pentagon on SpaceX.[96] SpaceX completed its first space tourism flight to the International Space Station in April 2022, the first such all-private mission ever.[97]

Russia's civil space program appears to be collapsing, deserted by international partners because of the Ukraine invasion and amid dramatic technical failures that Roscosmos has struggled to resolve. As NASA eliminates its reliance on Russian shuttles to carry astronauts to the International Space Station, Roscosmos's revenue is dwindling. Furthermore, NASA is on track to cut ties with Russia completely.[98]

Virgin Orbit is no more. In late March 2023, Richard Branson announced that his satellite company, Virgin Orbit, would cease operations and lay off 85% of its workforce after failing to secure needed funding.[99] On April 3, the company filed for Chapter 11 bankruptcy.[100]

NASA and Boeing postponed the first launch of the Starliner's eight-day Crew Flight Test (CFT) to the International Space Station (ISS) from early February to late July 2023 at the earliest — yet another in a series of delays in a program running years behind schedule. NASA engaged both Boeing and SpaceX a decade ago to shuttle astronauts to and from the ISS. While Boeing has yet to get one astronaut in space, SpaceX sent its seventh crew up in March 2023.[101]

Defense

Key takeaways

- Revenue in 2022 was down **3%** among the top six US defense companies, despite higher demand
- US dollar rose by **12%**, reducing international results
- BAE Systems and Thales both reported higher revenues in local currency, by **9%**
- Operating margins slipped on program performance issues, supply chain disruptions and labor constraints

Despite surging demand, overall revenues for the top 11 defense companies were down 4% year over year. The top six US defense companies reported an aggregate 3% decline. European defense companies all reported revenue increases in local currency. These were more than offset by a roughly 12% increase in the value of the US dollar, resulting in an aggregate 6% decline in revenues as translated into USD. European revenue performance is consistent with increasing defense budgets across Europe, partly attributable to the war in Ukraine. US companies' decline in revenue comes despite a 5% increase in the US DoD budget in FY22 and a 10% increase in FY23. The decrease in revenue is significantly attributable to production constraints associated with supply chain disruptions and labor shortages.

Operating profits for the largest 11 defense companies was down 25%: Off 29% for the top six US defense companies and 14% for the top five European defense companies. Only Northrop Grumman, Thales and L3Harris reported modest profit improvements. Boeing was responsible for nearly two-thirds of the profit decline, reporting an overall loss of $3.5 billion — a $5.1 billion decline from the prior year. Boeing's loss resulted from charges on multiple fixed-price development programs, including VC-25B, KC-46A, MQ-25, T-7A Red Hawk and Commercial Crew.

Lockheed Martin reported the best operating margin at 12.7%, despite an 8% decline in profits and 90 bp decline in operating margin. US operating margin decreased 310 bp, to 8.3%. European operating margin decreased 80 bp, to 8.4%. Rolls-Royce Defence reported the highest operating margin, 11.8%.

Figure 8: Backlog of defense orders (US$ billions)

	12/31/22	12/31/21
Lockheed Martin	$150	$135
Northrop Grumman	$79	$76
General Dynamics (excl. Gulfstream)	$72	$71
Raytheon	$69	$63
Boeing Defense, Space & Security	$54	$60
BAE Systems	$73	$61
Airbus Defence and Space and Helicopters	$62	$57
Leonardo	$39	$42
Thales	$43	$41
L3Harris	$21	$21
Total	**$662**	**$627**

Source: Company reports

Overview

Defense performance 2022

The story of the world's defense industry over the next decade is likely to be one of tremendous growth.[102] Total global military spending rose by 3.7% in real terms in 2022 to a fresh high of $2.24 trillion. The top-three spenders in 2022 — the US, China and Russia — accounted for 56% of the global total.[103] Collectively, the world's top ten defense companies earned $485.5 billion in 2021, with average revenue growth of 7.1%.[104] Revenues of the world's top 100 defense companies likewise climbed for the sixth year in a row.[105]

Notable developments and outlook

The war in Ukraine has changed Europe more than any other event since the end of the Cold War. Germany's announcement of an immediate $112 billion investment in its long-neglected armed forces is just one among many signs that, for defense manufacturing, a new era of European military procurement has dawned.[106] The anticipated effects of restocking and recapitalizing are likely still to come, as the need to replenish depleted stocks beyond previous levels yields firm orders. The new European geopolitical environment is likely to trigger a massive increase in demand for the European defense industry, which could see double-digit growth rates as high as 20% per year over the next economic cycle with the European countries as much as doubling their military spending in percentage of GDP terms.[107]

At least 40 countries have supplied military aid to Ukraine to date, and 18 have sent heavy weapons and committed more than 0.1% of their GDP to the effort (of these, only the United States and the United Kingdom are world leaders in defense aviation manufacturing).[108] The US leads all others in the war effort, having provided Ukraine with weapons and military equipment worth some $30 billion since the war began, dwarfing EU member states' contribution,[109] which amounts to about €12 billion ($12.95 billion) so far.[110] The progress of the allied effort has starkly revealed European reliance not only on American weapons but on American leadership as well.[111]

As they supply and resupply Ukraine, the United States and other NATO countries are draining their arsenals of many weapons new and old, and struggling to replenish them.[112] The list of dwindling weapons stocks 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 donated to Ukraine by Lithuania,[113] helicopters by the United Kingdom[114] and various models of Soviet-era MiG jets by former Soviet-bloc nations[115] — to name just a few. Eastern European members of NATO are especially eager to acquire newer and more advanced Western munitions and supplies.[116] 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.[117] In April 2023, the White House announced a further $2.6 billion worth of military aid to Ukraine, strongly focused on buttressing the country's air defenses. Recently leaked US documents revealed that such aid was very urgently needed.[118] The package included $500 million in ammunition and equipment from US military stockpiles[119] — the drawdown continues.

Ukraine will finally get fighter jets. The NATO war effort appeared to pass a milestone in March 2023 when Poland and Slovakia became the first member nations to promise fighter jets to Ukraine (specifically, 17 Soviet-era MiG-29s), fulfilling a desperate request made by Ukraine since the war's outbreak. The donated jets are likely to be replaced to some extent with South Korean FA-50s and US-made F-35s.[120] Still, no one should assume that donated materiel will necessarily always be replaced like for like. The US response to Slovakia's announcement, for instance, was to offer the country 12 new Bell AH-1Z Viper helicopters at a two-thirds discount.[121]

Like fighters, modern tanks are high on Kyiv's wish list. By some estimates, half of Ukraine's tank fleet (about 450 vehicles) consisted of captured Russian tanks by late 2022; Ukraine has also reportedly captured about 650 Russian armored vehicles.[122] The growing list of NATO and other allied countries committed to sending main battle tanks (MBTs) to Ukraine[123] passed a dozen in early 2023, including the United States, which accelerated its timetable for delivery of M1 Abrams tanks to autumn 2023.[124]

The year of war has seen a steady shift from the provision of ostensibly "defensive" weaponry to advanced armored vehicles and artillery intended to enable Ukraine to drive Russian forces from occupied territory[125] — a trend likely to persist. To cite just one example, the US in February agreed to send Ukraine the Ground Launched Small Diameter Bomb (GLSDB), which would allow Ukraine to hit targets twice as distant as those reachable by the High Mobility Artillery Rocket System (HIMARS) that the US has been supplying.[126]

The American effort to supply Ukraine raises concerns that the US could lack sufficient capacity to produce the weapons that the nation and its allies require at a time of increasing geopolitical tensions. Concern extends from tiny, mundane components such as ball bearings all the way up to missiles, air defense systems and counter-artillery radar. The Pentagon, the White House, Congress and military contractors are contributing, separately and in collaboration, to address the problems involved — but solving them could take years. [127] Procurement budgets are rising steeply. The White House's proposed budget for Air Force missile procurement alone would spring from $2.2 billion in 2021 to nearly $13 billion by 2028.[128]

The Ukraine war is also changing the Pentagon's approach to procurement. For the first time, the DoD is asking Congress to fund multiyear weapons purchases of missiles and ammunition, instead of placing orders annually.[129] Additionally, the US military is abandoning cost-cutting measures adopted after the end of the Cold War as a just-in-time approach to armaments inventory yields to direct support for increased production capacity. A rising volume of orders for US weapons from allies in Europe and Asia is also creating more demand that both puts stress on and supports enhanced US production lines.

South Korea sees opportunities for growth. As the war has fueled a global effort to produce munitions to fill the global rearmament gap, South Korea pivoted with exceptional speed to increase output. In 2021, South Korea's arms exports rose 140%, to a record $17.3 billion, including deals worth $12.4 billion to sell materiel including fighter jets and multiple rocket launchers to Poland, one of Ukraine's closest allies.[130] Other former Warsaw Pact countries that are now NATO members, all eager to replace their analog Soviet weapons with modern digital ones, may well follow Poland's lead. Countries unwilling or unable to buy arms from Russia might also turn to South Korea. The Philippines, for example, scrapped a deal to buy Russian helicopters in 2022 and is in the market.[131] South Korea has never ranked lower than 11th place in our annual Aerospace manufacturing attractiveness rankings, and most recently ranked 8th.

Has the world's first drone war changed warfare forever? There's never been an air war like the Ukraine air war — relying so little on manned aircraft. Russia largely stopped sending piloted aircraft into Ukrainian airspace in mid-2022.[132] While Russia relies on Iranian drones and an array of missiles, Ukraine's creative innovations in drone warfare[133] have given it an edge[134] and could have a transformative effect on both military technology and tactics.[135] For example, strikes on airfields and other targets deep inside Russian territory in early December 2022[136] appeared to show that Ukraine had developed an aerial drone with a range of up to 1,000 kilometers.[137] Apparently based on a Soviet-manufactured surveillance UAV, the weapon could reach most of western Russia.[138] As Russia struggled to respond, the two countries by late 2022 were in effect fighting "the first full-scale drone war."[139] By January 2023, Ukraine had even set up new drone assault companies, via a novel interministerial and interagency initiative. The units rely on SpaceX's Starlink satellite internet system.[140] Ukraine has even succeeded in strapping rocket-propelled grenades to cheap hobbyist racing drones to attack the Russian front lines.[141]

A new drone technology developed in Utah (10th place in our most recent Aerospace manufacturing attractiveness rankings among US states) made its successful battlefield debut in Ukraine in May. Donated to Ukraine by Fortem Technologies, the counter-unmanned aerial system Drone Hunter F700 captures Russian surveillance/reconnaissance drones by engulfing them in a net and then either grounding them or towing them back behind Ukrainian lines (where they can be fingerprinted and repurposed).[142] Less attention has been paid to the roles increasingly played by UAVs in noncombat sorties by the Ukrainians. Civilian drones made by the Canadian-US company Draganfly are being used for search and rescue operations, landmine detection and delivery of blood, medicines and other supplies to the front line.[143]

War in Ukraine has not diminished global concern with China's militarization. In efforts to keep pace with China's military advances, the Pentagon and the White House are seeking collaborative relationships with Silicon Valley start-ups to fund the development of new weapons technology.[144] US venture capital deal activity in A&D technology has risen steeply in recent years, from negligible amounts prior to 2015 to more than $7 billion in 2021 and to $6 billion in 2022. By comparison, some estimate the Chinese government's infusion of capital into its domestic tech sector as surpassing $1 trillion.[145] Now the White House has requested $115 million in funding for a new Pentagon entity called the Office of Strategic Capital (OSC).[146] The goal is to attract venture capital to companies producing technology and products critical to the military.

The shooting down of Chinese surveillance balloons in February 2023, in which Canadian and American military and civilian officials collaborated, put the NORAD [147] in the headlines for the first time in many years.[148] In June 2021, Canada announced the commitment of CDN$5 billion over six years to comprehensively modernize NORAD's badly aging systems.[149] 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 program aren't 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 Russian but also Chinese and North Korean missiles.[150]

In the "largest and most complex competitive procurement" in the history of Army aviation (according to an Army spokesperson), the Army announced in December its choice of Bell Textron to build the Future Long-Range Assault Aircraft (FLRAA). This program, officially launched by the Army in 2019, will fulfill a goal dating back about a decade of providing vertical takeoff and landing (VTOL) troop transport aircraft capable of reaching at least 322 mph. The aircraft will have a range of 2,810 miles without refueling. Initial acquisition will be worth up to $1.3 billion, a subsequent low-rate production phase of about $7 billion and total production, including potential foreign military sales, of perhaps $70 billion. The Army plans ultimately to replace about 1,200 Apache attack helicopters in a parallel program as well.[151]

In March 2023, the United States, the United Kingdom and Australia agreed to a joint program for production of eight next-generation nuclear submarines for the Australian navy, with a planned total investment of some $368 billion spread over three decades. The program is expected to create up to 20,000 direct jobs in defense for Australia (which has landed in the top ten in our Aerospace manufacturing attractiveness rankings every year since 2016.[152] The deal amounts, in effect, to a substantial expansion of the American submarine industrial base as well.[153]

Japan announced plans to spend 43 trillion yen ($313 billion) over the next five years to enhance its defense capability, doubling its military spending to about 2% of current gross domestic product — in line with NATO member states' target. Announced purchases already include significant US-made weapons systems, including Tomahawk cruise missiles.[154]

Boeing unveiled the concept for a tactical stealth-capable military cargo plane with a blended wing body (BWB) — the "flying wing" type familiar from the B-2 and B-21 bombers. The announcement came just two weeks after the Air Force publicly underlined a need for airlifters that can evade anti-aircraft attack from technologically advanced adversaries such as China.[155] While Boeing's concept aircraft remains in its development phase, it will be interesting to see if other players will try to compete in this space.

The Pentagon will soon make awards under its $9 billion Joint Warfighting Cloud Capability (JWCC) program after selecting four tech companies in December 2022 to compete for the contract. Work on the project could continue through 2028. The JWCC is intended to serve as armature of a "connect-everything-everywhere" campaign known as Joint All-Domain Command and Control (JADC2), complementing cloud initiatives already underway among US military services.[156]

One key to engineering next-generation defense aviation systems appears to be mastering the art of extreme speed. In December 2022, that US Air Force Research Laboratory (AFRL) announced an award of $334 million in contracts to several engineering companies to oversee the design, prototyping and testing of the Air Force's secret hypersonic bomber. Named Project Mayhem, the world's first hypersonic plane would be a replacement for the SR-71 and use "air-breathing" jets to reach speeds up to Mach 10.[157]

While the DoD presses forward with high-tech innovation, one major jet engine program has been rolled back. In late March 2023, the Air Force decided in its fiscal 2024 budget request not to proceed with replacing the F-35's F135 powerplant with either the GE Aerospace XA100 or the Pratt & Whitney XA101. Both had been developed as part of the multibillion-dollar Adaptive Engine Transition Program (AETP). Instead, the Air Force has chosen the lower cost Pratt F135 engine core upgrade (ECU), even though it will not provide the increase in range or fuel efficiency of either of the AETP options. Interoperability was the deciding factor.[158]

Not all the US military aviation news was made by jets and missiles at the cutting edge of speed. Sometimes old technology can be new again. Case in point: In August 2022, the US Special Operations Command (SOCOM) announced that the next craft in its arsenal would be a single-engine prop plane. The new plane will rely on cutting-edge sensor and laser-guided rocket technology. SOCOM will buy up to 75 AT-802U Sky Warden craft in a program called Armed Overwatch, to be built by L3Harris Technologies in collaboration with Air Tractor. The new fleet will support special operations forces, including Delta Force and Navy SEALs, in irregular warfare operations. The Sky Warden's design includes modular reconfigurable elements for versatility and ease of deployment. The aircraft is intended to be low-cost and robust in adverse environments. With an initial contract of $170 million, the deal could ultimately be worth up to $3 billion — a boon to the A&D industry in Texas, where the planes will be built.

In closing

Demand for aviation has never been more evident. While the COVID-19 crisis revealed that remote work can be highly productive, it also revealed limitations, such as challenges to working in complex teams, mentoring and development and, most importantly, building relationships with customers and clients. Restrictions on travel have revealed that businesses depend on the ability to move human capital through a globalized economy. Furthermore, consumer demand for aviation confirms that it is now much more inelastic than it was a decade or two ago. Consumers continue to prioritize experiences over goods. Air travel has become a middle-class standard, and consumers are willing to pay higher prices for it if they must.

By the end of 2023, aviation should return to pre-pandemic levels and resume a growth trajectory nearly double that of GDP. In the short term, the principal risks are persistent supply chain disruptions and labor challenges, including staff shortages and rising labor costs. In the longer term, the principal risks are threats to the industry's ability to achieve sustainability. Aviation's net zero carbon emissions by 2050 plan relies primarily on sustainable aviation fuel (SAF). The ability to scale SAF production at a reasonable cost is key to maintaining growth. Otherwise, myriad potential constraints loom, including regulatory volume limits, carbon taxes and negative consumer sentiment.

The defense industry should experience a year of significant growth in 2023. Given currently elevated geopolitical risks, global defense spending is setting new records each year. With defense budgets up by double digits in many countries, we can expect to see high single-digit growth in 2023. Supply chain and labor issues that significantly affected defense production in 2022 should continue to improve in 2023.

Furthermore, the space industry continues to expand at a rapid pace, as we continue to transition to a space-based economy, which will ultimately impact nearly all products and services. Given that 2022's overall industry revenue was just 4% below its previous record, expect the industry to set a new sales record in 2023. Although operating profits aren't likely to surpass the record level of 2018, which was 18% above 2022, they have the potential to grow by double digits in 2023.

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Appendices

Methodology

Our data are drawn from financial reports on FY2022 results for the largest 100 A&D companies by revenue (see below) and other publicly available information, such as company websites and press releases. Our cutoff date for publication was April 1, 2023.

A&D companies include those that generate the majority of revenue from aerospace or defense activities or, for diversified companies, those reportable segments that derive a majority of their revenue from A&D activities. The results are reported in US dollars. Foreign currencies were translated for the top 100 list at average exchange rates for years ended December 31, 2022, and December 31, 2021.

Our report also expresses PwC's point of view on topics affecting the industry, developed through interactions with our clients and other industry leaders and analysts.

A&D top 100 companies (ranked by 2022 revenue)

#	Company	Revenue (US$ millions) 2022	2021	Change	Operating Profit (US$ millions) 2022	2021	Change
1	Raytheon Technologies	67,074	64,388	4.2%	5,414	4,958	9.2%
2	Boeing	66,608	62,286	6.9%	-3,547	-2,902	-22.2%
3	Lockheed Martin	65,984	67,044	-1.6%	8,348	9,123	-8.5%
4	Airbus	61,791	61,642	0.2%	5,599	6,314	-11.3%
5	General Dynamics	39,407	38,469	2.4%	4,211	4,163	1.2%
6	Northrop Grumman	36,602	35,667	2.6%	4,253	4,217	0.9%
7	BAE Systems	26,212	26,851	-2.4%	2,940	3,286	-10.5%
8	GE Aerospace	26,050	21,310	22.2%	4,775	2,882	65.7%
9	Safran	20,529	18,034	13.8%	2,148	1,655	29.8%
10	Thales	18,474	19,139	-3.5%	2,035	1,949	4.4%
11	L3Harris	17,062	17,814	-4.2%	1,929	1,889	2.1%
12	Rolls Royce	16,671	15,431	8.0%	1,032	706	46.3%
13	Leonardo	15,471	16,708	-7.4%	1,011	1,077	-6.2%
14	Leidos	14,396	13,737	4.8%	1,088	1,152	-5.6%
15	Honeywell Aerospace	11,827	11,026	7.3%	3,228	3,051	5.8%
16	Huntington Ingalls	10,676	9,524	12.1%	565	513	10.1%
17	Textron	9,352	9,203	1.6%	1,027	975	5.3%
18	Booz Allen Hamilton	8,364	7,859	6.4%	685	754	-9.2%
19	SAIC	7,394	7,056	4.8%	85	390	-78.2%
20	Dassault Aviation	7,308	8,550	-14.5%	621	644	-3.5%
21	Bombardier Aviation	6,913	6,085	13.6%	538	241	123.2%
22	Singapore Technologies	6,552	5,724	14.5%	482	481	0.3%
23	CACI	6,203	6,044	2.6%	496	540	-8.1%
24	Howmet Aerospace	5,663	4,972	13.9%	919	748	22.9%
25	MTU Aero Engines	5,605	4,950	13.2%	910	842	8.1%
26	AVIC Aircraft Company	5,596	5,070	10.4%	76	107	-28.3%
27	Serco	5,591	6,087	-8.1%	268	297	-9.9%
28	Elbit Systems	5,512	5,279	4.4%	367	419	-12.4%
29	TransDigm Group	5,429	4,798	13.2%	2,215	1,691	31.0%
30	KBR Government Solutions	5,320	6,149	-13.5%	441	414	6.5%
31	Hanwha Aerospace	5,062	4,839	4.6%	290	242	20.0%
32	Babcock International Group	5,058	5,754	-12.1%	280	-39	826.1%
33	Rheinmetall Defence	5,050	4,785	5.6%	717	580	23.6%
34	Spirit AeroSystems	5,030	3,953	27.2%	-281	-459	38.8%
35	Israel Aerospace Industries	4,973	4,477	11.1%	316	217	45.6%
36	Maximus	4,631	4,254	8.9%	326	409	-20.3%
37	Mitsubishi Aircraft, Defense and Space	4,604	6,393	-28.0%	152	-863	117.6%
38	Embraer	4,540	4,197	8.2%	142	201	-29.4%
39	Saab	4,150	4,561	-9.0%	323	336	-3.9%
40	Trimble	3,676	3,659	0.5%	1,595	1,474	8.2%

A&D top 100 companies (ranked by 2022 revenue)

#	Company	Revenue (US$ millions) 2022	2021	Change	Operating Profit (US$ millions) 2022	2021	Change
41	Melrose / GKN Aerospace	3,646	3,498	4.2%	229	154	48.9%
42	Hindustan Aeronautics Limited (HAL)	3,132	3,095	1.2%	666	578	15.1%
43	Eaton Aerospace	3,039	2,648	14.8%	705	580	21.6%
44	MOOG	3,036	2,852	6.5%	240	238	0.8%
45	Vectrus	2,891	1,784	62.1%	56	62	-9.7%
46	ViaSat	2,788	2,256	23.6%	37	64	-42.2%
47	Curtiss-Wright	2,557	2,506	2.0%	423	383	10.4%
48	Parker Hannifin Aerospace	2,520	2,387	5.6%	501	403	24.3%
49	CAE Aviation Defense and Security	2,475	2,097	18.0%	215	18	1126.7%
50	Kawasaki Aerospace Systems	2,346	3,509	-33.2%	-74	-288	74.4%
51	Aerojet Rocketdyne	2,238	2,188	2.3%	145	257	-43.6%
52	BWXT	2,233	2,124	5.1%	349	346	0.9%
53	Heico Corporation	2,208	1,866	18.3%	497	393	26.5%
54	Korea Aerospace Industries	2,157	2,238	-3.6%	110	51	115.4%
55	Oshkosh Defense	2,141	2,507	-14.6%	46	164	-72.0%
56	Aselsan	2,129	2,262	-5.9%	730	1,058	-31.0%
57	IHI Aero Engines and Space Operations	2,017	2,290	-11.9%	-71	-365	80.6%
58	Ball Aerospace	1,977	1,911	3.5%	170	169	0.6%
59	Bharat Electronics	1,948	1,898	2.7%	402	396	1.4%
60	SES	1,944	1,782	9.1%	140	468	-70.1%
61	AAR	1,820	1,652	10.2%	107	85	25.9%
62	Constellium Aerospace & Transport	1,788	1,350	32.4%	228	131	73.9%
63	Swire Pacific / HAECO	1,766	1,475	19.7%	24	51	-53.4%
64	Allegheny Technologies High Performance Metals	1,641	1,155	42.1%	228	85	168.2%
65	Qinetiq	1,628	1,758	-7.4%	145	154	-5.6%
66	Maxar Technologies	1,605	1,770	-9.3%	11	176	-93.8%
67	Hexcel	1,578	1,325	19.1%	175	52	236.5%
68	Woodward Aerospace	1,519	1,404	8.2%	231	234	-1.3%
69	Triumph Group	1,460	1,870	-21.9%	104	-326	131.9%
70	Austal	1,429	1,572	-9.1%	120	115	4.3%
71	Indra Transport & Defense	1,404	1,486	-5.5%	181	177	2.0%
72	Kongsberg Gruppen Defense and Aerospace	1,233	1,186	4.0%	200	189	5.7%
73	Axon Enterprise	1,190	863	37.9%	93	-168	155.4%
74	Teledyne A&D Electronics and Engineered Systems	1,093	1,035	5.6%	223	182	22.5%
75	OHB Technology	1,053	1,070	-1.6%	66	56	19.2%
76	Exchange Income Corporation	1,028	731	40.5%	371	317	17.3%
77	RUAG	990	1,357	-27.1%	186	77	143.4%
78	Mercury Systems	988	924	6.9%	32	81	-60.5%
79	VSE Corporation	950	751	26.5%	55	22	150.0%
80	RBC Bearings	943	609	54.8%	130	111	17.1%

A&D top 100 companies (ranked by 2022 revenue)

#	Company	Revenue (US$ millions) 2022	2021	Change	Operating Profit (US$ millions) 2022	2021	Change
81	Kratos Defense & Security Solutions	898	812	10.6%	-3	28	-110.7%
82	Smiths Detection	808	992	-18.6%	44	106	-58.1%
83	Garmin Aviation	793	712	11.4%	213	193	10.4%
84	Ducommun	713	645	10.5%	40	49	-18.4%
85	Kaman	688	709	-3.0%	-66	49	-234.7%
86	Senior Aerospace	683	604	13.0%	25	11	127.5%
87	Crane Aerospace & Electronics	667	638	4.5%	120	110	9.1%
88	FACC	638	588	8.5%	6	-30	119.6%
89	Magellan Aerospace Corp Aerospace & Aviation	588	549	7.2%	-12	4	-408.4%
90	SIA Engineering	566	443	27.8%	-22	-25	12.0%
91	Chemring	546	541	1.0%	66	69	-4.4%
92	Astronics	535	445	20.2%	-30	-29	-3.4%
93	Latecoere	492	397	24.0%	-65	-81	-19.7%
94	Subaru Aerospace	474	799	-40.7%	-53	-89	40.4%
95	AeroViroment	446	395	12.9%	-10	43	-123.3%
96	Barnes Aerospace	429	362	18.5%	76	52	46.2%
97	Albany Engineered Composites	425	310	37.1%	77	56	37.5%
98	Heroux Devtek	412	457	-9.8%	36	27	32.8%
99	Larson & Toubro Defence Engineering	410	460	-10.8%	83	83	-0.4%
100	Esco Aerospace & Defense	351	315	11.4%	69	57	21.1%
	Total	**740,498**	**717,981**	**3%**	**67,039**	**62,285**	**8%**

Additional resources

2022 Aerospace manufacturing attractiveness ranking

Our analysis considers how various countries and American states compare in terms of their attractiveness as locations for all sectors of aerospace manufacturing.

Future of the Industry: Predictions for the Global Space Sector

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Contact

To have a deeper conversation about how this subject may affect your business, contact:

Scott Thompson
Global aerospace and defense leader
1.413.441.2702
scott.thompson@pwc.com