



Innovation to drive new opportunities

In 2022, the aerospace and defense (A&D) industry is expected to focus on innovation to develop new technologies and solutions, create new markets, and expand growth opportunities. Rapid evolution and commercialization of new technologies and processes can improve efficiencies and reduce costs. As the world heads into 2022, trends in commercial air travel and customer order activity are in much better shape than earlier post-COVID expectations, which is a positive sign for the industry. Global distribution of COVID vaccines is helping to clear a path toward normalization of air travel, though the current surge in Delta-variant infections in certain regions will likely keep demand for travel subdued into early 2022. But current macroeconomic trends suggest that demand for small- and medium-sized aircraft will continue to recover to reach pre-COVID levels in 2022, with aircraft manufacturers focused on narrow-body aircraft being well positioned to benefit from this buoyant demand. Furthermore, with air travel volumes now

well off the lows seen in 2020, aftermarket revenues could recover strongly in 2022 as air traffic rebounds. Defense markets are expected to remain stable as military projects continue to be a strategic priority and countries further strengthen their militaries. There are more reasons to be optimistic. Private sector innovation will likely continue to increase the potential value that space, as an economic resource, can create for industries and organizations. Furthermore, new technologies, evolving business models, and increasing M&A activity will likely further accelerate the shift toward digital and operational efficiencies. In particular, digital thread and smart factory present a host of efficiency- and productivity-enhancing technologies that can accelerate time to market and reduce cycle times. A&D firms that focus on innovation will likely be better prepared for 2022.



Digital thread and smart factory

Innovative deployment of digital thread and smart factory to drive efficiencies

Digital thread and smart factory could move into the mainstream of A&D company operating systems in 2022. Thirty percent of US manufacturers surveyed in a recent study reported they are currently implementing digital thread initiatives.¹ Global A&D supply chains have been affected by both demand-side shocks and supply-side disruptions in 2020 and 2021. Companies need flexible, agile systems that can self-optimize performance across a broader network, self-adapt to and learn from new conditions in real or near real time, and in some cases, run entire production processes autonomously. In 2022, A&D companies are expected to embrace digital thread and smart factory more broadly to gain critical material and component supply visibility to ensure efficient production and faster design to delivery.

Enabling the digital thread can be crucial for an A&D business to stay agile in today's shifting business environment. The digital thread connects across an A&D product's end-to-end life cycle, from the initial design to the final product—collecting live feedback along the way. Insights and actions enabled by the digital thread should help A&D companies speed up product time to market, reduce overall service costs, and stay flexible in meeting customers' ever-changing demands. Industry players will likely leverage the digital thread to streamline, design, adapt, and maintain products at every stage of the journey. They can:

- Use real-time intelligence to make more informed decisions about product design, performance, and value in the marketplace;
- Leverage data aggregation technologies with predictive analytics, cognitive, and machine-learning capabilities to improve forecasting accuracy and predictive modeling;
- Unlock supply chain transparency by linking all aspects of a commercial aerospace, defense, or space product to a chain of custody to address variant product and manufacturing specifications;

- Assess product performance in the marketplace and provide additional services beyond the current product; and
- Connect customers back to product design to reduce waste, carbon footprints, and over-production.

Similarly, to accelerate operational improvements as the global economy reopens at a wider scale, more industry players will likely connect their machines, people, data, and value chains to build and scale smart factory networks. A&D manufacturers, whether already running or yet to invest in smart factory technologies, are expected to reap business value from smart factory initiatives in 2022. In 2020 and 2021, we saw many A&D companies take advantage of the downturn to invest in advanced manufacturing capabilities like smart factory. In 2022, many A&D companies will likely roll out these investments more broadly across their organization and start benefitting from such investments. As the smart factory offers an integrated view of operations, A&D companies can uncover opportunities for improvement and make decisions across their global footprint. Consequently, smart factory solutions can help A&D organizations grow and reduce costs by increasing visibility, optimizing production, improving quality, and minimizing unplanned downtime.

Digitizing operations to build and scale a smart factory involves applying technology to unlock and empower people. Cloud-based dynamic scheduling solutions that identify where people are working, where materials are located, and the ways to synchronize them should unlock A&D factories' potential to meet changing customer demands. Also, such solutions can help an A&D manufacturer avoid disruptions and chart the most efficient path by harnessing big data, advanced analytics, and machine learning and delivering it in real-time, driving better outcomes.



Aftermarket

Recovery in air travel to drive focus on digital innovation for growing aftermarket revenues

Many aerospace manufacturers are seeking new aftermarket services revenue opportunities due to the pandemic-induced impact on customer demand and pricing pressure. The pandemic resulted in a substantial drop in aftermarket revenues and profits, so companies are looking for ways to capture more value from aftermarket as commercial aerospace recovery accelerates. Reducing costs and time to resolution, as well as managing risks are generally the key priorities for aerospace customers. To improve the customer experience, aerospace companies could invest in digital platforms in 2022 to enhance customers' visibility to production and material systems, integrate applications across platforms, and improve linkage to engineering data. Moreover, many companies will likely leverage digital technologies to offer proactive and predictive maintenance capabilities as these digital service offerings could help them gain a competitive edge and provide an enhanced customer experience.

Commercial air travel, particularly domestic travel, is recovering strongly. The total demand (measured in revenue passenger kilometers or RPKs) was down 56% in August 2021 (compared to August 2019 levels), which is a significant improvement from August 2020 when RPKs were down 75% (compared to August 2019 levels).² Global air travel demand is expected to recover to between 50% and 55% of 2019 levels in 2021 and 85% and 90% of 2019 levels in 2022.³ However, a key risk to this forecast is the potential for an unexpected surge in new and more infectious variants of the coronavirus disease. Recovery in air travel demand should drive an increase in aftermarket activity as higher aircraft utilization usually corresponds with increased maintenance, repair, and overhaul (MRO) work.

Acceleration in passenger traffic should power stronger commercial aftermarket revenues driven by maintenance and service of aircraft fleet, especially in the second half of 2022. Aircraft original equipment manufacturers (OEMs) are likely to continue to expand their aftermarket service offerings to capture increased demand aggressively. Pure-play MRO providers will likely collaborate and partner with smaller, regional competitors to expand their services business. As airlines increasingly move to performance-based service offerings, MRO companies should provide pay-per-use

and subscription-based services. Manufacturers of complex components will likely offer long-term service contracts to customers to expand their presence in MRO.

As travel demand recovers, OEM production rates are expected to ramp up, especially for narrow-body aircraft. Broader global distribution of vaccines in 2022 should lead to higher levels of international travel as restrictions are eased and lifted, which should translate into higher demand for new wide-body aircraft. This should result in some new large orders from airlines. Global commercial aircraft deliveries of between 1,000 and 1,025 aircraft are estimated in 2022, a decline of just 18% to 20% from 2019.⁴ The higher deliveries in 2022 are expected due to increased production rates by OEMs, including deliveries of aircraft that were produced and in inventory but couldn't be delivered in 2020 and 2021. While a portion of new deliveries will replace retiring aircraft, an overall growing fleet with increased utilization bodes well for aftermarket revenues. Many aircraft delivered before the pandemic will require maintenance before reentering service. So, maintenance events deferred in 2020 and 2021 will likely provide a lift in 2022.

Services powered by digital technologies could be a significant driver of revenues in 2022. Innovative digital technologies could hold the key to aftermarket success as the proliferation of smart parts and products opens new opportunities for digital service offerings. Innovation such as deploying AI and machine learning to provide proactive remote asset monitoring and predictive capabilities could be the critical differentiator for the OEMs, airlines, and pure-play MRO companies. Aftermarket service providers should optimize their services using advanced analytics and predictive applications (such as demand forecasting and predictive maintenance) and create new service offerings by utilizing access to performance data. They should proactively monitor customers' maintenance needs and advance customer engagement using digital platforms and data analytics. Furthermore, virtual and augmented reality technologies could likely help reduce the need for onsite technicians, further improving field service efficiency.



Advanced military capabilities

Defense contractors to leverage innovation for building advanced military capabilities

The defense industry has been considerably more insulated from the global impact of COVID-19 than the commercial aerospace industry, and the ongoing US government support for the National Defense Strategy is likely to keep defense spending stable in 2022. President Biden's budget proposal requests a \$753 billion budget for national defense (up 2% YoY).⁵ The strength in US military spending can be primarily attributed to heavy investment in research and development and several long-term projects such as the 5th generation F-35 Joint Strike Fighter and B-21 Long-Range Strike Bomber.⁶ This reflects growing concerns over perceived threats from strategic competitors such as China and Russia.⁷ However, the risks to defense spending over the medium term remain in place due to higher federal debt levels, though the likely scenario is that the budget stays flat.

With the US military gradually shifting its focus away from the Middle East to emerging threats in the Far East, defense companies should emphasize building improved capabilities in fighter aircraft, space resilience, shipbuilding, and cybersecurity to drive growth. This renewed focus could bode well for the major defense contractors sitting on record backlogs, which should support revenue growth in 2022 and beyond. Defense contractors are likely to enjoy strong demand for high-end military equipment in domestic and international markets, especially unmanned military fighter aircraft, cyber and intelligence solutions, and hypersonics. The major priorities for defense spending globally in 2022 could be:

- Interoperability within militaries, within government, between nations, and with industry to meet uncertain threats;
- Maintaining information superiority and the enabling information infrastructure; and
- Anticipating intelligent systems and autonomy.

As a result, defense contractors who build integrated and interconnected products with situational awareness systems could be well positioned to deliver stable revenue growth.

Total global military spending was also strong—it rose to \$1.98 trillion in 2020, an increase of 2.6% in real terms from 2019.⁸ This

increase in global military spending came in a year when the global gross domestic product (GDP) shrank by 4.4%.⁹ Consequently, military spending as a share of GDP reached a global average of 2.4% in 2020, up from 2.2% in 2019.¹⁰ This is the biggest year-over-year rise since the global financial and economic crisis in 2009. China's military expenditure, the second-highest globally, estimated at \$252 billion in 2020, rose 1.9% over 2019 and 76% over the decade 2011–2020.¹¹ China's military spending has risen for 26 consecutive years—the longest series of uninterrupted increases by any country. This ongoing growth in Chinese military spending is primarily due to the country's long-term military modernization and expansion plans, in line with a stated desire to catch up with other leading military powers such as the United States. Russia's military expenditure also increased by 2.5% in 2020 to reach \$61.7 billion, representing the second consecutive year of growth.¹² Global defense spending is expected to grow about 2.5% in 2022,¹³ as major world powers continue to strengthen their militaries in response to geopolitical tensions.

The pandemic exposed the degree to which weakened US supply chains pose a risk to its economic and national security. To address this challenge, the US Defense Critical Supply Chain Task Force is focusing on ways that defense supply chains can prepare to respond to supply shocks. For example, a key risk includes potential sanctions from China in response to congressional notifications of potential foreign military sales (FMS) to Taiwan. If China restricts the supply chain, including the supply of rare earth minerals and other raw materials, there will likely be a material impact on the extended defense value chain. The Task Force recommends that "DoD have visibility into the defense supply chain to understand its vulnerabilities and develop risk mitigation strategies, reduce reliance on adversaries for resources and manufacturing, and deploy the full range of American innovation to secure the supply chains involving rare earth elements."¹⁴ To future-proof defense supply chains and build resilience, the DoD will likely invest in developing predictive insights capabilities across the Defense Industrial Base (DIB). In particular, the investments will likely focus on application programming interfaces (APIs), hybrid-cloud infrastructures, graph processing frameworks, and microservice architectures to quickly develop and deploy analytics at scale.



Space market

Innovation to continue accelerating growth in space market

In 2022, developments along three key areas—the launch industry, satellite trends, and new technology—could drive growth in space-based services to offer tangible value for businesses, society, and consumers.

In the private sector space race between companies to be the first to put civilians into orbit, 2021 has been an inflection year. Alongside all the major developments of space tourism, applications of a new generation of satellites promise to revolutionize industries.

First, innovation should continue to drive down the cost to access low-Earth orbit (LEO). The biggest driver of launch cost is the cost of the rocket itself, which in the past has not been reusable beyond a single launch. Ever since SpaceX successfully reused parts from its Falcon Heavy rocket in 2019, there has been huge progress around reusability.¹⁵ Launch contracts for the public sector space, once reserved for a few state-owned enterprises, will likely continue to open to private industry through competitive bidding, pricing incentives, and performance-based contracts.

Second, the latest wave of small satellites (small sats) and nano satellites (nanosats) are expected to become even smaller, cheaper, and faster to produce than traditional satellites. The establishment of industry standards and increasing use of components from outside the space industry could result in a reduced development cycle, with the latest hardware and software able to be integrated more quickly.

Third, advancements in technologies such as rapid prototyping and space services should drive the growth of the space industry in 2022. Small sats will continue to become relatively easy to construct: the casing can be 3D printed, operating algorithms can be home programmed, launches can be booked online, and mission data can be stored and processed in the cloud. “Operations-as-a-service” should continue to be a growing cross-industry trend where space service providers increasingly provide ground station and specialty services, enabling operators to access data from their satellites without investing in their own ground network.

This ongoing innovation has laid the foundation for broad-based next-gen satellite telecommunications. In 2022, the explosion of small-sat constellations could shake up how broadband internet is distributed across the world and bring connectivity to communities and locations where previously not possible. Furthermore, in the field of Earth observation, satellites can increasingly capture terabytes of granular images from all corners of the Earth on a daily basis. This data can gradually be used by sophisticated software to generate insights that inform organizational decision-making.



Advanced air mobility (AAM)

AAM firms to start adopting new innovative business models

AAM is gaining increased momentum and gradually becoming mainstream, especially as companies developing electric vertical takeoff and landing (eVTOL) aircraft continue to receive substantial investment from sources ranging from traditional aerospace companies to private equity investors. Numerous organizations have already passed the research and development (R&D) stage and are currently performing testing and piloting. Certification, testing and evaluation, and prototype deployments are expected to gain further traction in 2022. For example, a leading developer of eVTOL aircraft, Archer Aviation, has completed an early milestone in eVTOL certification, enabling the company to move closer to its goal of obtaining a Federal Aviation Administration (FAA) type certification for its eVTOL aircraft.¹⁶

Government agencies such as the National Aeronautics and Space Administration (NASA) and the FAA have also taken leading roles in key research and policy areas. To collect vehicle performance and acoustic data for use in modeling and simulation of future airspace concepts, NASA is likely to increase flight testing of eVTOL aircraft as part of the agency's AAM National Campaign in 2022. The agency began eVTOL flight testing for the first time with Joby Aviation in September 2021.¹⁷ These tests should help identify gaps in the current FAA regulations and policies to help incorporate AAM aircraft into the National Airspace System. This multi-event campaign to advance airspace mobility in the United States is likely to occur at multiple locations in 2022 and beyond.

As the market for AAM in the United States alone is estimated to reach \$115 billion annually by 2035,¹⁸ competition is likely to be intense, and therefore companies in this ecosystem should gain an edge by being first movers. AAM companies should formulate a

solid business strategy for successful commercial operations now, while the industry is still evolving. They should evaluate and identify the operating business models and consumer segments where the most significant opportunities lie—aligned with their strategic vision, core expertise, and organizational capabilities.

As AAM companies work toward addressing diverse mobility needs, they should start planning their operations primarily through four types of business models:

1. Pure-play OEMs whose primary business includes the design, development, and manufacturing of eVTOL aircraft
2. eVTOL fleet operators providing air taxi and charter services
3. Mobility-as-a-service (MaaS) providers who would primarily develop technology platforms to connect end-customers to on-demand and scheduled air taxi services
4. Vertically integrated companies where eVTOL OEMs forward integrate into air taxi and charter services to capture the complete AAM value chain

However, a key consideration for AAM companies in 2022 would be to determine whether existing capabilities allow them to deliver value to the major customer segments—and if not, how can they build the required capabilities?



Decarbonization

Innovative technologies and solutions to drive decarbonization

2020 and 2021 saw increased public pressure on the A&D industry, especially in commercial aerospace, to implement environmentally sustainable manufacturing practices and promote a significant shift toward lowering carbon emissions. 2022 could be the year all companies make decarbonization commitments—not only in their operations but also for their products. While the industry has been at the forefront of adopting new and advanced manufacturing technologies to increase fuel efficiencies, now is the time for A&D companies to leverage advanced technologies more than ever to drive innovation to help address the sustainability challenge. The industry should focus on technological and operational improvements and develop new systems and alternatives to jet fuel to significantly reduce emissions. Some companies are making good progress in understanding the emissions they directly generate. But mapping their emissions footprint across the value chain can be a far more significant challenge.

In 2022, A&D companies are likely to further the shift toward sustainable manufacturing—reducing Scope 1 emissions (emissions an A&D company makes directly during manufacturing) and Scope 2 emissions (emissions an A&D company makes indirectly during manufacturing and operations). This comprises designing and building commercial and military products through economically sound processes that minimize negative environmental impacts while conserving energy and natural resources. For example, Boeing is progressing toward meeting its 2025 environmental targets in its operations with a goal of reducing greenhouse emissions, specifically, by 25% in 2025 from its 2017 baseline.¹⁹ The four main areas where sustainable practices can drive measurable improvements across the value chain include:

- Improving product design and engineering using advanced technologies such as digital twin, rapid prototyping, and additive manufacturing;
- Ethically selecting and sourcing sustainable alternative materials;
- Forging the factory of the future by combining smart technologies and green energy; and
- Streamlining shipping and distribution through supply chain reconfiguration and rationalization of trade routes.

Calculating, then reducing, Scope 3 emissions (emissions an A&D company is indirectly responsible for when its products are used, such as emissions from an aircraft in flight) can be an intimidating prospect. For most A&D companies, Scope 3 emissions represent 70% of their total carbon footprint.²⁰ While companies have less control over these emissions, addressing them can be critical for lowering total industry emissions. As such, in 2022, A&D companies should consider different promising technologies that are emerging to reduce Scope 3 emissions in the long term. Some of these include sustainable aviation fuels (SAFs) made from renewable feedstock and scalable innovations related to new propulsion technology, including electric propulsion. 2022 could see increased commitments globally from the energy companies to increase the production of SAFs, as well as from the airlines and corporate customers to use SAF to power flights. However, implementing economically feasible and scalable solutions and scaling production requires regulatory support possibly in the form of incentives.



Mergers and acquisitions (M&A)

Companies with strong financial discipline expected to use M&A to drive growth in emerging technologies

The industry experienced solid values and volumes of M&A activity during the first half of 2021. With \$61 billion worth of deals through August 31, 2021, compared to a deal value of \$22 billion in 2020, M&A activity remained strong in 2021.²¹ In 2022, deal activity should remain strong—innovation, technology transformation, and geopolitical and regulatory shifts will likely drive a robust deal environment across all the industry segments: commercial aerospace, defense, and space. Global deal activity is also likely to be driven by improved liquidity, especially at financially strong companies that may prioritize M&A to drive long-term growth.

As industry players reevaluate their portfolios and focus on divestments of non-core assets, well-prepared companies with strong balance sheets should make smart M&A decisions that create increased shareholder value. While post-pandemic recovery will likely remain a key driver for M&A in commercial aerospace, geopolitical tensions could continue to support deal-making in defense. Government agencies clamoring for innovative technology could prompt prime and subprime contractors to acquire nimble startups in space.

With an evolving industry landscape, megamergers might take a back seat. Activity will likely focus on acquisitions that deliver innovative capabilities and expand into new markets such as electric propulsion, hypersonics, and space tourism. As such, A&D companies should prepare for the opportunities and challenges in executing such mergers or acquisitions. For example, companies should consider how to value a company with a short financial track record or that has few competitors or that is located in a country in which they have not previously operated. Integrating overseas has its hurdles, potentially resulting in inefficient operations and failure to realize acquisition benefits.

Private equity (PE) investors should continue to seek A&D companies looking for capital investments. PE investors are likely to focus on companies where they can acquire proprietary intellectual property, as well as those working on supply chain rationalization and growing aftermarket business. In defense, PE investors should be focusing on technology innovation and companies working on advanced military capabilities like unmanned aircraft and hypersonics.

Special-purpose acquisition companies (SPACs) are also expected to remain a significant factor in boosting A&D industry M&A in 2022 as private investors remain interested in new technologies such as space tourism. As the cost of commercial space exploration continues to decline, smaller launch vehicles should continue to provide access for potential new entrants in 2022, which will likely further drive organizations of all sizes to pursue M&A to provide enhanced space services. Many innovators are entering the realm of space technology with truly unique offerings that should start unlocking sizable demand for unique segments such as space tourism.

The United States is likely to pursue stringent foreign investment rules designed to protect critical elements of the DIB, which could prevent some cross-border M&A deals, including restricting opportunistic acquisitions by foreign entities. Moreover, the Committee on Foreign Investment in the United States is likely to continue to review any acquisitions by companies with ties to foreign governments.²²



Digital innovation could be the key to industry recovery and growth

Despite multiple significant challenges, the A&D industry has weathered the pandemic's disruption due to strong order books, and 2022 is expected to be the year where A&D companies will focus on rebuilding lost revenue streams, increasing agility in operations, and recalibrating supply networks to serve changing market demands. As the industry recovers, companies that focus on digital innovation could thrive, particularly those that prioritize greater efficiency in their engineering, manufacturing, and supply chain processes by implementing digital thread and smart factory solutions. By investing in digital initiatives across production and the supply network, A&D manufacturers can solve specific challenges such as fluctuating demand. This comprises data capture and analysis across their manufacturing footprint to identify breakpoints and opportunities for improvement. Moreover, the heightened use of digital technologies such as additive manufacturing and cognitive can contribute to a more sustainable future.

Let's talk



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