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REFORGING THE U.S. AIRCRAFT INDUSTRIAL BASE

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Executive Summary

The U.S. Aircraft Industrial Base (AIB) stands at a critical inflection point. As strategic competition intensifies, particularly with China, America's ability to project airpower and maintain deterrence will depend on the health and resilience of the AIB. While the Department of Defense's 2023 National Defense Industrial Strategy (NDIS) and its 2025 Implementation Plan (NDIS-IP) chart an ambitious course for revitalizing the broader defense industrial base, they devote limited attention to the aircraft sector. This paper bridges that gap by assessing the strengths and vulnerabilities of the AIB and offering recommendations to apply, supplement, or complement the implementation initiatives identified in the NDIS-IP in ways that will make the aircraft industry more robust and resilient.

The research reveals a sector under strain. Workforce shortages, reliance on foreign sources for critical minerals, and regulatory frameworks that fail to align with strategic needs undermine the AIB's ability to respond to both peacetime production demands and wartime surge requirements. Compounding these challenges is a rigid intellectual property regime and an export control system that hinder collaboration with trusted allies, slow innovation, and constrain industrial flexibility.

The paper argues for a shift in approach that embraces modernization, allied collaboration, and targeted policy reform. It recommends accelerating the adoption of additive manufacturing, rebuilding domestic capacity for critical mineral processing, and expanding strategic stockpiles to reduce vulnerabilities in the production supply chain. To address chronic workforce gaps, the paper calls for a nationally coordinated strategy that links federal investments with educational institutions and incentivizes careers in advanced manufacturing.

Equally important is the need to rethink how the U.S. engages its allies. Moving from a "Buy American" mindset to a "Build Allied" strategy would enable joint development, reduce overhead costs, and expand surge capacity. Reforming International Traffic in Arms Regulations and Export Administration Regulations through expanded waivers and streamlined licensing processes would strengthen interoperability, support multinational programs, and counterbalance adversarial influence. Reforms in intellectual property policy must also match these efforts by balancing government access with industry protection, particularly to encourage participation from non-traditional defense firms.

The paper also addresses the need for infrastructure modernization through global sustainment partnerships. It recommends leveraging existing relationships and commercial Maintenance, Repair, and Overhaul capabilities to build a more distributed, resilient maintenance ecosystem aligned with U.S. strategic basing needs. Further, it argues for using current unmanned systems programs, such as the Collaborative Combat Aircraft initiative, as a springboard to revitalize crewed air dominance through more frequent and cost-effective production cycles, including the Light Fighter and Digital Century Series concepts.

In conclusion, the paper emphasizes that sustaining U.S. air dominance requires more than advanced aircraft; it demands a robust, flexible, and modernized industrial ecosystem. The aircraft industry must be deliberately integrated into the NDIS-IP's implementation if the United States is to meet future defense challenges. By embracing innovation, fostering allied collaboration, and reforming outdated policies, the Department of Defense can ensure the AIB remains a cornerstone of American national security for decades to come.

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1.0 Introduction

The Department of Defense's 2023 National Defense Industrial Strategy (NDIS) "lays out long-term priorities that will guide DoD actions and resource prioritization with the aim of creating a modern, resilient defense industrial ecosystem designed to deter U.S. adversaries and meet the production demands posed by evolving threats."[1] It focuses on four "critical areas" that apply across the defense industrial ecosystem.[2] The department subsequently released the NDIS Implementation Plan (NDIS-IP) for 2025, identifying six primary implementation initiatives, each with multiple supporting Lines of Effort (LOE).[3] Although the NDIS-IP implementation initiatives are largely industry agnostic, there is significant emphasis on ships, submarines, and munitions, and little reference to aircraft or the aircraft industry.

Unlike the NDIS or NDIS-IP, this paper focuses on one industry. It delves into the current state of the aircraft industry and compares its analysis against the NDIS's assessment of the larger defense industrial base. It then offers specific recommendations to apply, supplement, or complement the implementation initiatives identified in the NDIS-IP in ways that will make the aircraft industry more robust and resilient.

Before proceeding, two points of emphasis about prioritization are necessary. First, although the aircraft industry is critical to national security, there is no claim in this paper regarding the priority of one industry versus another. The NDIS-IP's emphasis on munitions and maritime capabilities remains important to national security. Second, this paper prioritizes

[1] Joseph Clark, "DoD Releases First Defense Industrial Strategy," Department of Defense, last modified January 12, 2024, https://www.defense.gov/News/News-Stories/Article/Article/3644527/dod-releases-first-defense-industrial-strategy/

[2] These critical areas include: 1) Resilient Supply Chains, 2) Workforce Readiness, 3) Flexible Acquisition, and 4) Economic Deterrence

[3] The six implementation initiatives include: 1) Indo-Pacific Deterrence, 2) Production and Supply Chains, 3) Allied and Partner Industrial Collaboration, 4) Capabilities and Infrastructure Modernization, 5) New Capabilities Using Flexible Pathways, and 6) Intellectual Property and Data Analysis. This paper will describe these initiatives in more detail in section 3.0.

among the many potential initiatives that could strengthen the aircraft industrial base. As such, it does not address every challenge or opportunity facing the aircraft industry but rather highlights only those that the authors identify as the most important.

1.1 The Aircraft Industrial Base and Stakeholder Interests

As an important part of the overall Defense Industrial Base (DIB), the Aircraft Industrial Base (AIB) is a cornerstone of national security, technological innovation, and economic strength.[4] The aircraft industry encompasses all firms engaged in the research, design, development, manufacture, repair, maintenance, and disposal of aircraft products.[5] The aircraft industry links commercial and military aviation through a shared network of manufacturers, suppliers, and sustainment providers that drive economic prosperity and enable U.S. airpower, readiness, and deterrence.

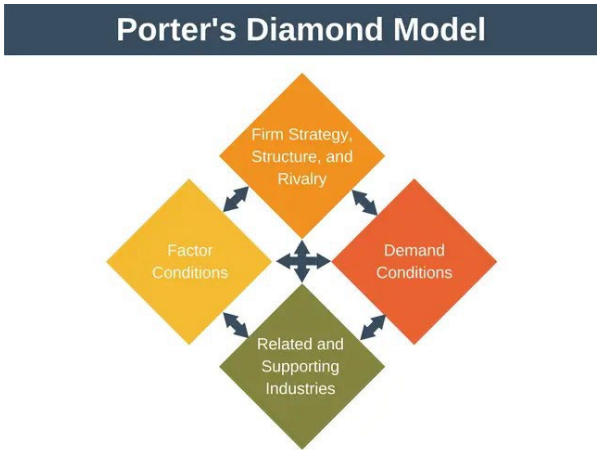
Key structural characteristics shape the AIB and explain its strategic and economic importance. It operates as an oligopoly, dominated by a few prime contractors. This structure exists within a DoD monopsony, where the government is the sole buyer, wielding significant buyer power that shapes the industry's structure, conduct, and performance.[6] The need for advanced military platforms with greater technical complexities drives increased cost and development time. These dynamics contribute to industry consolidation and international collaboration, particularly in Europe. Additionally, barriers to entry remain high due to the capital intensity, regulatory hurdles, and the need for cutting-edge technology. The defense and commercial aircraft markets are partially integrated, with some firms like Boeing and Airbus

[4] The AIB referenced in this paper specifically references the defense aircraft industrial base.
[5] Keith Hartley, *The Political Economy of Aerospace Industries: A Key Driver of Growth and International Competitiveness?* (Cheltenham, UK: Edward Elgar Publishing Limited, 2014), 2 – For the purpose of this paper, Hartley's definition was modified to replace aerospace with aircraft.
[6] Keith Hartley, *The Political Economy of Aerospace Industries: A Key Driver of Growth and International Competitiveness?* (Cheltenham, UK: Edward Elgar Publishing Limited, 2014), 28

operating in both sectors, while others specialize. Substitutes such as long-range missiles and space-based systems are also reshaping demand.

The AIB also faces growing competition from both adversaries and allies. Strategic competitors like China, the world's second-largest aviation market, are rapidly expanding aircraft capabilities through state-supported firms such as Commercial Aircraft Corporation of China.[7] At the same time, allied and partner nations are pursuing greater AIB autonomy. European countries have increased investments in joint projects such as the Eurofighter Typhoon and Future Combat Air System (FCAS), seeking to maintain industrial competitiveness and reduce reliance on U.S. suppliers.[8]

2.0 Strategic Analysis of the Aircraft Industrial Base



In a contested geopolitical landscape, the strength of a nation's AIB is foundational to its ability to deter adversaries and prevail in conflict. The U.S. aircraft industry is confronting challenges, threatening its ability to meet future defense demands. To assess these issues, Porter's Diamond Model offers a valuable lens for evaluating the aircraft industry's competitive advantage in terms of its strength, resilience, and ability to support current and future national security objectives.[9] Applying this model to the

[7] Joe Anselmo, et al., "After Tariff, Aerospace And Defense Sees Nothing But Uncertainty," Aviation Week, last modified April 17, 2025, https://aviationweek.com/aerospace/manufacturing-supply-chain/after-tariffs-aerospace-defense-sees-nothing-uncertainty

[8] "Future Combat Air Systems (FCAS): Shaping the Future of air power," Airbus, accessed May 8, 2025, https://www.airbus.com/en/products-services/defence/future-combat-air-system-fcas

[9] Michael E. Porter, "The Competitive Advantage of Nation," Harvard Business Review 68, no. 2 (March-April 1990): 73-93

aircraft industry reveals where government and industry must act to reshape the AIB, ensuring it remains robust, agile, and aligned with the nation's strategic needs.

2.1 Factor Conditions

Factor conditions highlight the available natural, infrastructure, capital, and human resources necessary for industry competitiveness.[10]

Qualified human resources are a critical factor. The aircraft industry faces workforce shortages of skilled labor and Science, Technology, Engineering, and Mathematics (STEM) experts at all levels of the supply and production chain. [11] As aging talent exits the workforce, recruitment efforts struggle to keep up with demand.[12] Without a steady pipeline of skilled labor, the U.S. risks falling behind adversaries, weakening its industrial base.[13] Recruiting skilled labor remains a top industry priority, with one OEM projecting a need for 716,000 new maintenance technicians over the next two decades.[14]

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[10] Michael E. Porter, "The Competitive Advantage of Nation," Harvard Business Review 68, no. 2 (March-April 1990): 77

[11] Brooke Weddle, Giulietta Poltronieri, and Hugues Lavandier, "The talent gap: The value at stake for global aerospace and defense," McKinsey & Company, last modified July 17, 2024, https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/the-talent-gap-the-value-at-stake-for-global-aerospace-and-defense.

[12] "On the Horizon: Workforce Trends in the Aerospace and Defense Industry," Aerospace Industries Association, last modified May 2024, 8, https://www.aia-aerospace.org/wp-content/uploads/On-the-Horizon-AIA-PwC-Spring-24-Workforce-Study.pdf. This report highlights that the industry has been discussing approaching mass retirements because roughly 25% of the aerospace and defense workforce has over 20 years of experience and has reached or surpassed retirement age.

[13] Derek Constanza, Brian Prentice, Matt Poitras, Oksana Bardygula, Brian Fasano, Sam Sargent, Livia Hayes, and Carlo Franzoni, "Not Enough Aviation Mechanics: How the industry can address this decades' shortage in aircraft maintenance workers," Oliver Wyman, accessed on April 16, 2025, https://www.oliverwyman.com/content/dam/oliverwyman/v2/publications/2023/jan/Not%20Enough%20Aviation%20Mechanics%20-%20AMT%20report.pdf. This reports highlights concerns that projections of the number of workers expected to retire over the next few years are too big to be offset by hiring alone, and the industry will face a shortage.

[14] "Pilot and Technician Outlook 2024-2043," Boeing, accessed April 14, 2025, https://www.boeing.com/commercial/market/pilot-technician-outlook#overview.

The aircraft industry's reliance on foreign sources for critical minerals remains a strategic vulnerability.[15] This risk is heightened when supplier nations have an interest in conflict with the U.S., jeopardizing the ability to rapidly produce aircraft.

Regulatory infrastructure plays a critical role in shaping the operations, innovation, and competitiveness of the aircraft industry. Currently, the Federal Aviation Administration (FAA) provides robust oversight and generally aligns with European regulators. These regulatory bodies may be trending towards excessive risk aversion, given multiple aviation mishaps in the recent decade. While intended to improve safety, this shift may increasingly delay aircraft certification and modernization timelines. Similarly, the U.S. has strong intellectual property (IP) protections, but defense firms are becoming more reluctant to share proprietary technologies with the government due to insufficient safeguards. If regulatory bodies fail to align with national security priorities, the AIB will struggle to fully leverage innovation and competition to meet future defense needs.

Lastly, capital is critical to the aircraft industry for innovation, production, and surge capacity. However, DoD's shifting priorities, budget delays, and acquisition inefficiencies drive inconsistent demand signals. This uncertainty makes it difficult for firms to invest long-term in future capabilities. In the absence of stable government support, some firms pursue private financing, such as venture capital. This course of action often favors short-term gains over high-risk R&D and the sustained development of critical defense capabilities, leaving needed capabilities underfunded.

[15] This includes materials like titanium and rare earth elements used in advanced platforms such as the F-35 and B-21. China dominates much of the global rare earth supply chain, creating risks for U.S. manufacturing if geopolitical tensions escalate or supply is disrupted.

Despite its technological strengths, these factor conditions highlight the increased risks to national security from the U.S. AIB. Coordinated action across workforce development, supply chain resilience, regulatory and acquisition reform, and stable, consistent financial investment, aligned with the NDIS-IP, can better position the industry for future demand conditions. Ultimately, combat readiness and modernization will depend on addressing these factor conditions in peacetime before they become critical liabilities in wartime.

2.2 Demand Conditions

Demand conditions include the nature and size of the domestic market and how customers create expectations and drive innovation in the aircraft industry. If consumers are demanding, companies must develop better products to stay ahead of competitors. Therefore, strong demand can drive innovation and quality and enhance the advantage of an industry's products in global markets.

Monopsonistic demand patterns from the DoD directly dictate the type and amount of business available to the aircraft industry, impacting its structure and capabilities.[16] As the sole domestic buyer of military aircraft, the DoD's demand for a relatively small portfolio of exquisite systems drives a reliance on only a handful of primary defense contractors. This historically led to decreased competition and a de facto monopoly on major systems in the aircraft industry.[17] While this limits competition and could lead to production delays and cost overruns, the AIB has historically offset some of these effects through strong export markets to allies and partners, which provide additional demand signals and sustain industrial capacity beyond DoD contracts.

[16] John Birkler et al., *Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry*, RAND Corporation, 2003, p. 61.
[17] Ginny Wydler, Su Chang, and Erin M. Schultz, "Continuous Competition as an Approach to Maximize Performance," *Defense Acquisition Research Journal*, vol. 20, no. 1 (January 2013), accessed April 20, 2025, p. 41.

Defense contractors must extend their aircraft life cycles, relying on long-term Operations and Sustainment (O&S) contracts to maintain profitability due to fiscal uncertainty.[18] At the same time, rising readiness requirements are driving demand for enhanced Maintenance, Repair, Overhaul, and Upgrade (MRO&U) capabilities and infrastructure. As China increases its military investment, the United States intensified efforts to reduce aircraft downtime and maintenance costs to sustain a ready force.

The Replicator Initiative (RI) and the Collaborative Combat Aircraft (CCA) program are driving demand for unmanned aircraft and commercial derivatives, accelerating investment in Unmanned Aerial System (UAS) technology.[19] These initiatives also fuel broader adoption of emerging technologies such as additive manufacturing (AM), robotics, and automation, which promise to reduce costs and production timelines.

However, the globalized aircraft supply chain has exposed new risks, prompting demand for enhanced cybersecurity. In response to threats such as compromised components and cyber vulnerabilities, the industry has begun incorporating Zero Trust Architecture (ZTA) into aircraft systems to secure operations across multiple domains.[20]

Demand signals will continue to evolve. U.S. technological standards are pushing allies and partners to adopt stricter quality control, faster delivery timelines, and better regulatory compliance to improve interoperability and aircraft performance.[21] Ultimately, the aircraft

[18] Office of the Under Secretary of Defense for Acquisition and Sustainment, *State of Competition within the Defense Industrial Base*, Department of Defense, February 2022, p. 5.
[19] Birkler et al., *Competition and Innovation*, p. 91.
[20] ZTA is a comprehensive security approach that requires all users and entities trying to connect to a network to be authenticated and authorized before being granted access to any data or applications and has been driven by consumer security demands.
[21] Jorge Saldaña, "Aerospace Industry Seeks Collaboration with the UK," MEXICONOW, July 19, 2023, https://mexico-now.com/aerospace-industry-seeks-collaboration-with-the-uk/.

industry's ability to stay competitive and resilient will depend on how effectively it adapts to these complex and shifting demand pressures.

2.3 Related and Supporting Industries

Related and supporting aircraft industries considers the presence, quality, and international competitiveness of supplier industries, which play a crucial role in enhancing the competitive advantage of firms within a nation or region.[22] Some related and supporting industries in the military aircraft industry include academic and training institutions, raw material suppliers, advanced manufacturing companies and software, AI, and cybersecurity companies.

Academic and training institutions support the aircraft industry by developing a skilled workforce of engineers, technicians, and aerospace professionals. One of the top barriers to finding workers is the lack of qualified candidates due to the high demand for skilled trade and STEM workers.[23] Companies rely on local colleges, trade schools, and universities to strengthen their workforce pipelines. Additionally, academic research partnerships with industry and government agencies help develop innovative technologies, improve manufacturing processes, and enhance aircraft safety and performance. Although these public-private partnerships are proving successful, they aren't to the scale needed to meet future workforce demands.

Raw material suppliers are vital to the aircraft industry because they provide high-performance materials essential for lightweight, durable, and fuel-efficient aircraft. Material supply disruptions can interrupt commercial and military aircraft production, making supply

[22] "What Is Michael Porter's Diamond Model? Understanding Competitive Advantage | Zorgle," July 14, 2024, https://zorgle.co.uk/what-is-michael-porters-diamond-model-understanding-competitive-advantage/. Robust and resilient industries support the aircraft industry by providing advanced technology, high-quality inputs, specialized services, and shared knowledge.

[23] "Vital Signs 2025: The Health and Readiness of the Defense Industrial Base," National Defense Industrial Association, February 2025, https://www.ndia.org/-/media/sites/ndia/policy/vital-signs/2025/vitalsign_2025_final.pdf.

chain continuity a critical concern. Advanced materials enable innovation in aircraft development, with suppliers often playing a key role in R&D partnerships.

The AM industry offers improvements in production speed, cost, and/or precision of certain aircraft components while offering aircraft performance benefits. Leading defense primes such as Boeing and Northrop Grumman have demonstrated the operational viability of AM across unmanned systems and aircraft sustainment. At the same time, adjacent sectors, including artificial intelligence, machine learning, and advanced materials, enhance AM's precision, scalability, and integration.[24]

AI and data infrastructure drive critical advancements in the defense aviation industry. Leading technology firms like Microsoft, Google, and Palantir provide data architecture and machine learning tools that power industry innovation. Collaboration with educational institutions and research entities, such as DARPA-supported university partnerships with Aurora Flight Sciences, enhances the industry's innovation ecosystem.[25] Many firms that lack the digital resilience to support rapid AI integration struggle to modernize their supply chains, particularly among Tier 2 and Tier 3 suppliers.[26]

Cybersecurity firms are vital in protecting the aircraft industry from persistent and sophisticated cyber threats. Due to the high value of its technical data and IP, the aircraft industry is a lucrative target for cyberattacks. As technologies evolve rapidly, companies must

[24] Michael Petch, "Insights into Additive Manufacturing at Boeing with Leo Christodoulou," 3D Printing Industry, February 28, 2017, https://3dprintingindustry.com/news/insights-additive-manufacturing-boeing-leo-christodoulou-106718/.
[25] Aurora Administrator, "Autonomy," Aurora Flight Sciences, accessed April 30, 2025, https://www.aurora.aero/autonomy/.
[26] "The Role of AI in Developing Resilient Supply Chains | GJIA," *Georgetown Journal of International Affairs* (blog), February 5, 2024, https://gjia.georgetown.edu/2024/02/05/the-role-of-ai-in-developing-resilient-supply-chains/.

continuously update and harden their systems to avoid cybersecurity breaches, as seen by the push for more secure architectures such as ZTA.[27]

The U.S. military aircraft industry depends on a strong network of supporting industries to sustain its competitiveness. While academic partnerships help develop talent and drive innovation, workforce pipelines are not scaling fast enough to meet demand. Meanwhile, disruptions in raw material supply threaten production continuity. Advanced technologies like AI and AM offer major benefits, but many smaller suppliers lack the infrastructure to implement them. Cybersecurity risks are increasing as digital integration becomes more common, exposing vulnerabilities across the supply chain. Related and supporting industries present significant challenges and valuable opportunities for the defense aircraft sector. Ensuring their effectiveness will require increased investment from both government and industry to strengthen the stability and competitiveness of the broader DIB. Specific policy recommendations later in this paper offer ways to address these issues.

2.4 Firm Strategy, Structure, and Rivalry

Firm strategy, structure, and rivalry refer to how companies are created, organized, managed, and the nature of domestic competition.[28] Some factors include IP protection, government procurement policies, incentives for R&D, and responses to competitive threats.

Safeguarding IP is a core concern shaping a firm's strategy and competitive conduct in the defense aviation sector. Many firms in the DIB show increasing reluctance to include valuable proprietary technologies in government proposals, sometimes declining DoD contracts

[27] Zachary Collier and Joseph Sarkis, "The Zero Trust Supply Chain: Managing Supply Chain Risk in the Absence of Trust," *International Journal of Production Research* 59 (n.d.): 3430–45, https://doi.org/10.1080/00207543.2021.1884311.

[28] Michael E. Porter, "The Competitive Advantage of Nation," Harvard Business Review 68, no. 2 (March-April 1990): 77. This dimension examines the national environment for organization, management, and the intensity of domestic competition as a primary driver of innovation and global competitiveness

altogether. This caution stems from fears of IP misappropriation that could potentially destroy their technological edge. Data for 2025 indicated that over a third of qualified defense contractors opted out of some DoD contracts due to IP concerns, hindering efforts to boost competition and attract new DIB entrants.[29]

Government procurement policies heavily shape industry structure and firm strategies. Traditional "Buy American" mandates, intended to support domestic sourcing, can inadvertently limit competition, increase costs, and stifle innovation by excluding capable allied partners. Additionally, the DoD has traditionally favored large, long-term programs awarded to established primes, reinforcing industry consolidation and limiting opportunities for smaller or start-up firms. This bias creates barriers that prevent start-ups from entering the market and discourages innovation from nontraditional players. As a result, the AIB is increasingly concentrated, reducing competitive pressure and limiting the diversity of solutions available to meet evolving defense needs.

Technological advancements are critical to a firm's strategy and rivalry. Competitive pressures and evolving global threats push major contractors to invest in R&D for enhanced agility, cost reduction, and shorter development cycles.[30] However, traditional, risk-averse acquisition structures often impede full-scale adoption of the newest technologies. A strategic shift towards modularity, decentralized production, and rapid iteration, supported by reformed acquisition policies like DoD Instruction 5000.93, is necessary.[31] Similarly, leadership in AI

[29] "Vital Signs 2025: The Health and Readiness of the Defense Industrial Base," National Defense Industrial Association, February 2025, https://www.ndia.org/-/media/sites/ndia/policy/vital-signs/2025/vitalsign_2025_final.pdf.
[30] Jim Romeo, "The Evolution of 3D Printing and Additive Manufacturing," Military & Aerospace Electronics, June 22, 2023, https://www.militaryaerospace.com/computers/article/14293727/additive-manufacturing-3d-printing.
[31] Department of Defense, DoD Instruction 5000.93: Use of Additive Manufacturing in the DoD, accessed April 30, 2025, https://static.e-publishing.af.mil/production/1/saf_aq/publication/dodi5000.93_dafi63-149/dodi5000.93_dafi63-149.pdf.

adoption and its integration into mission-critical systems is rapidly becoming a key competitive differentiator.

Rivalry within the U.S. defense aircraft industry remains high. Established prime contractors face potential disruption from innovative startups leveraging AI, digital engineering, and agile methods. While barriers to entry are substantial, new entrants seek to bypass traditional industry chokepoints. Furthermore, the threat of substitution from increasingly sophisticated unmanned and autonomous systems intensifies pressure on incumbent firms to innovate continuously.

Maintenance, repair, and overhaul (MRO) strategies also reflect competitive positioning. Some firms pursue vertical integration, developing or acquiring MRO capabilities to secure long-term service contracts and enhance their value chain control. Others form strategic partnerships with independent MRO facilities to broaden service portfolios and geographic reach. Investment in advanced technologies—such as predictive analytics, robotics, and digital twins for improved MRO efficiencies—is another critical avenue for gaining a competitive edge.[32]

National security priorities, procurement policy, and rapidly evolving technologies shape firms' structure, strategy, and rivalry in the U.S. defense aircraft industry. These dynamics present both challenges and opportunities for the industry. These issues can be mitigated and addressed through targeted policy recommendations discussed later in this paper.

2.5 Summary of Challenges, Threats, and Opportunities

The U.S. defense aircraft industry demonstrates both strengths and critical vulnerabilities across the four elements of Porter's Diamond. Factor conditions present the most foundational

[32] Mordor Intelligence, "Military Aviation MRO Market Size & Share Analysis – Growth Trends & Forecasts (2025-2030)," accessed April 29, 2025, https://www.mordorintelligence.com/industry-reports/military-aviation-maintenance-repair-and-overhaul-market.

challenges. Skilled labor shortages compounded with strategic vulnerabilities in access to critical minerals and budgetary uncertainty threaten production readiness and long-term national security. If left unaddressed, these factor conditions will become operational weaknesses when rapid production and surge capacity are vital in a future conflict. The subsequent discussion on NDIS-IP initiative two will address this challenge, providing recommendations to tackle this issue.

Demand conditions highlight key opportunities to address the DoD's evolving need for advanced capabilities. CCA, RI, and enhanced MRO&U requirements are driving demand for innovation in autonomy, AI, AM, and cyber-resilient systems. However, acquisition delays, budgetary pressures, and regulatory roadblocks constrain demand, reducing innovation, especially with new entrants. These issues are addressed through NDIS-IP initiative four, five, and six, which outline specific solutions.

Related and supporting industries offer both a challenge and an opportunity. The U.S. benefits from the mature ecosystem in AM, AI, cybersecurity, and raw material suppliers. However, scale limitations in education and training programs, cybersecurity vulnerabilities, and uneven digital infrastructure with lower-tier suppliers lead to increased risks. The uneven readiness in these supporting industries presents a lack of resilience in the DIB. NDIS-IP initiatives two and six directly respond to this issue with tailored policy recommendations.

Firm strategy, structure, and rivalry highlight a growing threat. The industry's structure, shaped by government procurement and national security priorities, led to a heavily concentrated market with high entry barriers. Concerns over IP misappropriation, burdensome "Buy American" mandates, and risk-averse acquisition practices disincentivize innovation and drive firms away from DoD contracts. Despite this, competition is intensifying with the rise of startups

and technology disruptors, particularly in the unmanned and autonomous systems space. Firms that fail to adapt to these pressures risk losing relevance. To mitigate this challenge, initiatives three, four, and six of the NDIS-IP propose actionable solutions.

In conclusion, the competitive strength and future direction of the U.S. aircraft industry are defined by how firms navigate these complexities. Addressing the challenges and capitalizing on opportunities are crucial for maintaining a robust and technologically superior DIB that meets evolving national security demands. The nation will sustain U.S. airpower dominance only if it addresses these interconnected issues through coordinated actions, many of which the following recommendations detail.

3.0 NDIS-IP: Initiative Recommendations for the Aircraft Industrial Base

3.1 Introduction to the NDIS-IP

The NDIS-IP represents a critical step in ensuring America's continued technological and military superiority in an era of intensifying strategic competition.[33] The NDIS-IP translates the vision and objectives outlined in the NDIS into concrete actions and initiatives to strengthen and modernize the defense industrial base. The implementation plan structures around six main initiatives designed to address the NDIS strategic priorities mentioned previously.[34]

Stakeholders such as the Aerospace Industries Association applauded the NDIS-IP because it lays the groundwork to expand both the capacity and capability of the industrial

[33] "OUSD A&S - Industrial Base Policy," accessed April 29, 2025, https://www.businessdefense.gov/NDIS.html.
[34] (1) Indo-Pacific Deterrence: Focusing on strengthening deterrence in the Indo-Pacific region; (2) Production and Supply Chains: Strengthening domestic production and supply chains to reduce vulnerabilities; (3) Allied and Partner Industrial Collaboration: Enhancing collaboration with allies and partners to build a more resilient defense industrial base; (4) Capabilities and Infrastructure Modernization: Modernizing the defense industrial base, including critical infrastructure and capabilities; (5) New Capabilities Using Flexible Pathways: Exploring new ways to develop and acquire capabilities using more flexible acquisition strategies; (6) IP and Data Analysis: Leveraging IP and data analysis to improve decision-making and innovation.

base.[35] This paper makes policy recommendations based on the initiatives of the NDIS-IP and tailored to the aircraft industry that would improve overall U.S. national security. These recommendations will not address every challenge or threat, but this paper will provide the groundwork for enhancing the aircraft industrial base.

3.2 Initiative 2: Production and Supply Chains

The Production and Supply Chain initiative aims to manage aircraft defense production supply chains and reduce dependence on foreign sources of concern.[36] As such, this section addresses specific challenges relating to surging production through Additive Manufacturing (AM), onshoring, strategic stockpiling, and workforce challenges. It also reinforces NDIS efforts to improve industrial capacity and contribute to resolving specific vulnerabilities addressed within the NDIS-IP.[37]

3.2.1 Additive Manufacturing

The U.S. AIB is actively pursuing AM rapid prototyping for non-critical parts and small batch components, reflecting a cautious but growing integration of the technology. Pilot programs such as the Replicator Initiative, AM Forward, IDREAM4D and DoD Man Tech explore applicability within autonomous and manned platforms while maintenance depots and OEMs are using AM to reduce part lead times and alleviate supply chain bottlenecks, particularly for legacy platforms.[38] However, to unlock AM's full wartime potential and surge

[35] Sue Perez, "AIA President and CEO Applauds Pentagon's Strategy to Build Up Defense Industrial Base," Aerospace Industries Association, October 29, 2024, https://www.aia-aerospace.org/news/aia-president-and-ceo-applauds-pentagons-strategy-to-build-up-defense-industrial-base/.
[36] Department of Defense. *National Defense Industrial Strategy Implementation Plan for FY 2025*. https://www.businessdefense.gov/docs/ndis/2023-NDIS.pdf
[37] Ibid.
[38] Janina Lamoglia. *FRCSW Enhances Fleet Readiness with 3D Printing Technology*. October 23, 2024. https://frcsw.navair.navy.mil/Public-Affairs-Office/News/Article/3943944/frcsw-enhances-fleet-readiness-with-3d-printing-technology/

capacity, the United States must transition to full AM integration and a strategically coordinated ecosystem. Below are several recommendations to tackle this problem:

1. The development of a secure, end-to-end digital tracking platform by the Defense Logistics Agency under the guidance of the Under Secretary of Defense for Acquisition and Sustainment (OUSDA&S) to monitor AM supply chains, materials, and production in real-time.[39]
2. Utilization of Title III authority to fund AM infrastructure expansion, incentivize domestic mining of rare earth elements critical to AM, and enhance private sector participation, with coordination at the OSD level.[40]
3. Co-location of AM production centers near major military bases and defense logistics hubs to enable faster turnaround and surge capacity during crises, directed by OUSD(A&S) and executed under the Deputy Assistant Secretary of Defense for Industrial Base Resilience (DASD-IBR).[41]
4. Shift from rigid technical specifications to performance-based AM standards under FAA and DoD, focusing on performance outcomes rather than inflexible specifications and broad standards, ensuring rapid certifications while maintaining airworthiness.[42]

[39] Beth Reece. U.S. Department of Defense. *Leaders Outline Agency's Role in DoD Additive Manufacturing Capabilities*. February 16, 2023 https://www.defense.gov/News/News-Stories/Article/Article/3301150/leaders-outline-agencys-role-in-dod-additive-manufacturing-capabilities/
[40] Air Force Research Laboratory (AFRL). *Defense Production Act (DPA) Title III. Advancing the Industrial Base to Defend the Nation.* https://afresearchlab.com/technology/successstories/defense-production-act-title-iii/
[41] Assistant Secretary of Defense. Industrial Base Policy. *DASD Industrial Base Resilience*. https://www.businessdefense.gov/ibr/
[42] Inside Metal Additive Manufacturing. *Technical Insights for Metal AM Deployment*. May 15, 2024. https://insidemetaladditivemanufacturing.com/2024/05/15/prescriptive-or-performance-based-qualification-approach-for-metal-am/

5. Establish a comprehensive AM cybersecurity framework led by DoD, National Institute of Standards and Technology, and Cybersecurity and Infrastructure Security Agency to better safeguard digital files and manufacturing data against espionage and sabotage.[43]

AM promises lifecycle cost reductions through lower inventory overhead and on-demand production, but requires substantial initial investments in machines, materials, and cybersecurity for digital threads. Continuous efforts to improve cybersecurity infrastructure will mitigate associated risks regarding IP theft and cyber vulnerabilities. Additive manufacturing offers superior maintainability, adaptability, and deployability, especially in forward-deployed operations where contested supply chains limit traditional logistics support. Enhancing interoperability between allies and partners will increase the benefit for wartime readiness or during regional crises.[44]

3.2.2 Onshoring Critical Minerals

The U.S. AIB's dependence on Foreign Entities of Concern (FEOCs) poses a significant risk to national security.[45] This recommendation focuses specifically on onshoring mining, refining, and processing these essential inputs, not broader reshoring initiatives. Supply chains for critical materials are acutely vulnerable, with China dominating the mining and, crucially, the mid-stream refining and processing of numerous materials like graphite and gallium, while Russia has been a key supplier of titanium sponge. This concentration creates a "dangerous and

[43] Industrial Cyber. *DoD Finds Additive Manufacturing Systems Not Adequately Protected from Cybersecurity Risk*. July 09, 2021. https://industrialcyber.co/news/dod-finds-that-additive-manufacturing-systems-not-adequately-protected-from-cybersecurity-risk/

[44] Sven Clement. North Atlantic Treaty Organization (NATO). *NATO Parliamentary Assembly: 2023 Special Report on Novel Materials and Additive Manufacturing*. October 7, 2023. https://www.nato-pa.int/document/2023-novel-materials-report-clement-033-stc?form=MG0AV3

[45] Mahnaz Khan et al*., "Strategic Defense Critical Minerals: A Targeted List for National and Economic Security."* September 24, 2024. https://www.silverado.org/reports-and-publications/strategic-defense-critical-minerals/

costly dependence" that strategic competitors could weaponize, directly conflicting with the NDIS goal of eliminating dependencies on China.[46] The United States exhibits high import reliance (100% for 14 critical minerals in 2017) and lacks sufficient domestic production and processing capacity.[47] Over 90% of materials identified as National Defense Stockpile (NDS) shortfalls in FY2023 had either none or a single domestic supplier.[48] Price volatility, market opacity (often influenced by China), and limited visibility into sub-tier suppliers exacerbate these risks.[49]

The NDIS proposes mitigation strategies centered on incentivizing domestic capacity and capabilities of critical materials via the DPA, Title III.[50] While the DPA can fund such capacity, building the capacity requires significant scale, cost, and time.[51] Stockpiling raw ores offers limited utility without robust domestic processing capacity, highlighting that DoD action must tightly integrate stockpiling with large-scale investments in domestic processing.[52]

OSD, in coordination with the Departments of Commerce and Energy, must lead a unified whole-of-government effort to rebuild domestic processing capabilities. Beyond the DoD, Congress must authorize multi-year funding to close critical gaps. At the same time, the

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[46] Brett B. Adams. *House Committee on Foreign Affairs Subcommittee Hearing, Supply Chain Vulnerabilities & National Security Risks Across the U.S. Defense Industrial Base.* July 25, 2013. https://docs.house.gov/meetings/FA/FA14/20130725/101216/HHRG-113-FA14-Wstate-AdamsB-20130725.pdf?eType=EmailBlastContent&eId=3dc8fb11-f362-4b56-8669-5d0236d61ff6

[47] U.S. Geological Survey, 2023, *Mineral commodity summaries 2023: U.S. Geological Survey*, 210 p., https://doi.org/10.3133/mcs202

[48] U.S. Government Accountability Office. *National Defense Stockpile: Actions Needed to Improve DOD's Efforts to Prepare for Emergencies, GAO-24-106959*. September 2024. https://www.gao.gov/products/gao-24-106959

[49] Resilinc Editorial Team. *Securing Aerospace and Defense Supply Chain Resiliency: Key NDAA FY 2025 Insights.* Resilinc. March 6, 2025. https://www.resilinc.com/blog/securing-aerospace-and-defense-supply-chain-resiliency-ndaa/.

[50] LaPlante, William A., *National Defense Industrial Strategy Implementation Plan for FY2025* (Washington, D.C.: Department of Defense, 2024), 23, https://www.businessdefense.gov/docs/ndis/NDIS%20Implementation%20Plan_Revised_03182025_508.pdf

[51] Cameron M. Keys. Emergency Access to Strategic and Critical Materials: The National Defense Stockpile. Legislation, Defense & Intelligence, November 14, 2023. https://www.congress.gov/crs-product/R47833.

[52] Cameron M. Keys. *Defense Primer: The Defense Logistics Agency*. Legislation, December 12, 2024. https://www.congress.gov/crs-product/IF11543.

Departments of State and Treasury must support export controls and investment restrictions that prevent adversarial control over key U.S. industrial assets. Defense primes and material suppliers must re-engineer procurement practices to prioritize domestic and allied sources. Without coordinated leadership and revitalized investment, the AIB will remain fragile, vulnerable to economic coercion, and incapable of scaling under wartime conditions.[53]

Specific actions recommended to mitigate critical material risks and support onshoring include actively using DPA authorities and other investment mechanisms. The aim is to directly fund and incentivize establishing or expanding domestic capacity for refining and processing key critical materials (e.g., lithium, cobalt, titanium sponge) to complement raw material stockpiling. Deepening allied industrial cooperation to implement concrete burden-sharing arrangements for stockpiling critical materials, joint sourcing initiatives, and developing integrated processing capabilities is also crucial, leveraging expanded DPA definitions of "domestic source".

The cost of onshoring is substantial, and failure to do so risks the AIB's speed and flexibility necessary to win modern-day high-end and protracted conflict. Successful onshoring of critical minerals will increase availability of strategic materials, while improving sustainability, as dependence on adversarial suppliers diminishes.[54]

3.2.3 Strategic Stockpiling

Strategic stockpiling—the deliberate accumulation of critical materials, components, and potentially finished goods—emerges as an indispensable instrument for bolstering industrial

[53] White House. *Modernizing Defense Acquisitions and Spurring Innovation in the Defense Industrial Base*. April 9, 2025. https://www.whitehouse.gov/presidential-actions/2025/04/modernizing-defense-acquisitions-and-spurring-innovation-in-the-defense-industrial-base/

[54] Bridget McCrea. Supply Chain Management Review. *Managing the Risks and Rewards of Onshoring & Reshoring*. March 1, 2024. https://www.scmr.com/article/managing_the_risks_and_rewards_of_onshoring_reshoring

resilience.[55] It functions as a crucial buffer against disruptions, aligning with the national defense strategy by mitigating risks inherent in globalized supply chains, geopolitical volatility, and unforeseen crises. Modern U.S. military aircraft depend on a portfolio of specialized materials such as Titanium and alloys (Titanium sponge is a specific National Defense Stockpile concern), Aluminum and alloys, Rare Earth Elements (REEs), composite materials, superalloys, and other critical minerals (e.g.,).[56] The ”2023 Notice of Final Determination on DOE Critical Materials List” contains the most current list of critical materials due to their essentiality and supply chain vulnerability, with 12 specifically listed as "strategic defense critical minerals" posing significant risk due to reliance on FEOCs.[57] Implementing a focused stockpiling approach is critical for reinforcing the AIB’s resilience by addressing material vulnerabilities, supporting the NDS, and planning for infrastructure expansion.[58]

The National Defense Stockpile faces challenges and risks associated with five distinct gaps that must be addressed by DoD and Congress. Securing these requirement gaps will insulate critical aspects of the stockpile and improve AIB resilience in a near-peer conflict. First, DoD struggles to accurately model material needs for national emergencies, lacking data for over 40% of strategic materials.[59] Second, the gap between requirements and inventory is vast and growing (99 material shortfalls in FY2023, up 167% from FY2019), with current inventory mitigating less than half of estimated military shortfalls.[60] Third, addressing shortfalls requires an estimated

[55] Department of Defense. *National Defense Industrial Strategy Implementation Plan for FY2025*. 2024. https://www.businessdefense.gov/docs/ndis/NDIS%20Implementation%20Plan_Revised_03182025_508.pdf
[56] Linda R. Rowan. *Critical Mineral Resources: National Policy and Critical Minerals List*. Legislation, Energy & Natural Resources. February 21, 2025. https://www.congress.gov/crs-product/R47982
[57] Mahnaz Khan et al., *Strategic Defense Critical Minerals: A Targeted List for National and Economic Security*. September 24, 2024, https://www.silverado.org/reports-and-publications/strategic-defense-critical-minerals/
[58] Air Force Research Laboratory (AFRL). *Defense Production Act (DPA) Title III. Advancing the Industrial Base to Defend the Nation.* https://afresearchlab.com/technology/successstories/defense-production-act-title-iii/
[59] U.S. Government Accountability Office. *National Defense Stockpile: Actions Needed to Improve DOD's Efforts to Prepare for Emergencies.* GAO-24-106959. September 10, 2024, https://www.gao.gov/products/gao-24-106959
[60] Ibid.

$18.5 billion, far exceeding the $912 million amount currently allocated to NDS and the capacity of its self-funding mechanism, the NDS Transaction Fund (NDSTF).[61] Next, biennial reports to Congress have been incomplete regarding shortfalls and risk assessments.[62] Finally, over 90% of FY2023 shortfall materials lack sufficient domestic suppliers.[63]

To close critical gaps in the NDS and enhance the resilience of the AIB, the following actions are recommended:

1. The DoD must strengthen its modeling of material supply shortages in the NDS to better estimate demand in a crisis or conflict.
2. The DoD should actively use DPA Title III authorities to stimulate domestic production of critical minerals and reduce FEOCs.
3. Congress must enforce rigorous and complete biennial reporting from the DoD, ensuring transparency around stockpile shortfalls.
4. Legislative action is needed to directly appropriate funds to material gaps. These must be targeted appropriations beyond the limitations of the NDSTF to reduce shortfalls.

Continued neglect of the stockpile endangers mission readiness. Interruptions in the supply of critical materials risk delaying or halting the production of platforms essential for maintaining air superiority in a conflict.

[61] U.S. Government Accountability Office. *National Defense Stockpile: Actions Needed to Improve DOD's Efforts to Prepare for Emergencies.* GAO-24-106959. September 10, 2024, https://www.gao.gov/products/gao-24-106959
[62] U.S. Government Accountability Office. *National Defense Stockpile: Actions Needed to Improve DOD's Efforts to Prepare for Emergencies.* GAO-24-106959. September 10, 2024, https://www.gao.gov/products/gao-24-106959
[63] Ibid.

3.2.4 Workforce

The AIB faces a critical workforce challenge threatening national security.[64] A lack of skilled labor in the industry is a problem that can't be fixed overnight. One OEM firm indicated it takes 18-24 months to produce a skilled laborer.[65] Aware of future rising labor shortages and growing production pressures, both the aircraft industry and the U.S. government are taking meaningful steps to rebuild their workforce. From investing in internal training initiatives to expanding recruitment pipelines through college partnerships, prime aircraft contractors and suppliers are finding new ways to attract and retain talent.[66] Additionally, numerous federal and state programs focus on building the workforce pipeline. These efforts recognize that workforce development is no longer optional but essential to maintaining a national competitive advantage. Key challenges like recruitment and retention stem from a lack of national integration across workforce initiatives, unstable funding, and the lingering stigma against manufacturing careers, causing a shortage in the workforce.[67] These gaps weaken the industrial base's readiness and ability to sustain aircraft production.

To build a resilient and sustainable workforce, both the private sector and the U.S. government must adopt a coordinated, long-term national strategy addressing recruitment and perception of manufacturing careers head-on. They must implement targeted solutions focused

[64] Deloitte. Energy and Industrials. *2025 Aerospace and Defense Industry Outlook*. October 23, 2024. https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/aerospace-and-defense-industry-outlook.html
[65] An executive from this OEM related this assessment to the author under Chatham House rules during a 2025 visit.
[66] Across the industry, multiple firms have in-house training initiatives teaching their mechanics fundamental skills and capitalizing on upskilling efforts. One firm's training program particularly stands out, Northrop Grumman. The Aeronautic Systems Training for Advanced Refinement (ASTAR) program delivers hands-on training to new aircraft mechanics before they start on the Northrop Grumman production floor. Also, Lockheed Martin offers apprenticeships with hands-on training and benefits to attract employees. Furthermore, firms are involved in public-private partnerships with educational institutions by partnering with local colleges and trade schools to strengthen their workforce pipelines.
[67] Localized efforts from state programs produce uneven results across the aerospace sector. Fluctuating government investment, including potential cuts to Department of Education (DoEd) programs, threatens essential technical education pathways.

around two key areas: (1) expanding federal investment in training and education[68] and (2) incentivizing recruitment while destigmatizing manufacturing careers. Some specific examples to expand current federal investments include: increase federal and state governments partnerships with academic institutions to bolster workforce development in aircraft manufacturing, expand DoD's Industrial Base Analysis and Sustainment program to fund initiatives to strengthen workforce skills in priority sectors, and increase Career and Technical Education (CTE) investments. A way to incentivize recruitment is for the federal government to offer more tuition assistance for students entering technical programs. Additionally, it can provide student loan forgiveness for individuals with STEM degrees who serve in defense-critical manufacturing roles.

The DoD's Office of Industrial Base Policy and its Manufacturing Capability Expansion and Investment Prioritization office should lead this effort. This office is best positioned to lead a national coordination effort, in partnership with the Department of Labor (DoL) and the Department of Education (DoE). The DoD has both the strategic imperative and funding mechanisms (e.g., the Defense Production Act Title III and NDIS) to align private-sector needs with national security priorities. The DoL can support workforce development through grants, apprenticeships, and labor data integration. The DoEd can promote manufacturing career pathways through STEM and Career Technical Education in high school and community colleges. Also, a sustainable solution will require significantly increasing and stabilizing federal funding for workforce development programs, specifically those focused on technical education, trades, and early-career pipelines.

[68] The FAA grant program has funded partnerships between aviation employers and community colleges to create technician pipelines. Industrial Base Analysis and Sustainment aligned national defense needs with the stand-up of training facilities nationwide. While these programs are good, they aren't on a grand enough scale. They must be expanded.

The future of U.S. aerospace dominance and defense readiness depends on rebuilding and sustaining a skilled aircraft manufacturing workforce. While the NDIS has rightly prioritized workforce development, current efforts remain fragmented and under-resourced. There is a need for a more targeted and nationally coordinated approach led by the DoD and its partners to rapidly scale training pipelines, invest in technical education, and retain critical talent. Without decisive action, the AIB will face increasing difficulty meeting defense demands. Rebuilding human capital is achievable with the right focus, and nations that invest in their workforce strengthen industrial resilience and long-term security.

3.3 Initiative 3: Allied and Partner Industrial Collaboration

The FY2025 NDIS-IP calls on the DoD to "enable and promote closer coordination with allies and partners" through co-development and co-production of defense systems, and international industrial collaboration.[69] Embracing a clear "Build Allied" policy—with Congressional backing—would significantly strengthen the U.S. Aircraft Industrial Base (AIB). Strategic industrial partnerships enhance manufacturing capacity, reduce overhead costs, accelerate innovation, and ensure supply chain resilience, while aligning U.S. and allied national security objectives.

"Build Allied" also supports infrastructure investment, promotes regulatory harmonization, and necessitates reforms to outdated U.S. export controls that hinder defense co-development. If enacted, it would create a more agile, competitive, and interoperable AIB capable of addressing tomorrow's strategic challenges with the best technologies from across the alliance network.

[69] "National Defense Industrial Strategy Implementation Plan for FY2025," Department of Defense, 2024, 35.

3.3.1 Buy American vs. Build Allied

While "Buy American" policies aim to protect domestic jobs and encourage onshoring, they risk constraining the AIB by limiting competition, slowing innovation, and excluding critical allied industrial capabilities. Many allied-domiciled firms operate U.S. subsidiaries and already support major programs like the F-35, which sources components from over 1,900 global suppliers. Overreliance on a narrow domestic supply base contradicts the collaborative nature of modern aircraft design, development, and sustainment.

Leading defense firms and Pentagon officials argue that industrial policy should focus less on rigid domestic sourcing and more on building a diversified, flexible, scalable supply chain that includes trusted allied partners. A formal "Build Allied" strategy would expand competition within the AIB, increase the number of suppliers, alleviate supply chain bottlenecks, and promote co-investment in shared technologies while reinforcing geopolitical alliances. This would also strengthen diplomatic and military alliances and foster closer ties and cooperation between the United States and its allies (e.g., See Appendix 3 for a U.S.-Mexico industrial cooperation case study).[70]

While U.S. law permits such acquisitions and partnerships between U.S. and allied firms, the complexities and politics of defense acquisitions have stymied competitive bids led by allied-domiciled companies. A clearly stated, embraced, and implemented "Build Allied" policy, led by the Under Secretary of Defense for Acquisition & Sustainment, would empower Pentagon acquisition officials to prioritize allied industrial collaboration and encourage allied-domiciled company involvement early in new DoD programs. Furthermore, senior-level guidance promoting the benefits of "Build Allied" across the DoD's contracting community is required to

[70] Jerry McGinn and Michael Roche, "A "Build Allied" Approach to Increase Industrial Base Capacity," George Mason University Center for Government Contracting, June 22, 2023.

increase awareness and adoption both within Pentagon program offices and throughout the U.S. AIB.[71]

3.3.2 ITAR/EAR Impact on the Aircraft Industry

Export control regimes—particularly ITAR and EAR—frequently obstruct collaboration with trusted allies, despite their intent to protect U.S. technology. These regulations delay production, discourage co-development, and diminish U.S. competitiveness in global defense markets. Complex restrictions, such as the "see-through rule," make even minor U.S.-made components barriers to whole-system exports, straining allied relations and hampering procurement timelines.

Examples like France's sale of the Système de Croisière Autonome à Longue Portée (SCALP) missile sale to Egypt, stalled by a single U.S.-controlled part,[72] highlight how ITAR/EAR can become geopolitical liabilities. Allied partners are increasingly pursuing ITAR-free alternatives, reducing U.S. leverage and weakening cooperative R&D. These restrictions also raise the cost of compliance, delay timelines, and degrade interoperability, availability, and resilience of shared aircraft platforms. There has been precedent to allow ITAR/EAR waivers. The U.S. signed the Defense Trade Cooperation Treaties with Australia and the United Kingdom in 2007 and 2010. These treaties waived some ITAR licensing requirements for pre-approved entities within each country. This waiver accelerated defense collaboration in joint programs like the F-35.[73] The U.S. should consider increasing waivers for its most trusted allies.

[71] Jerry McGinn and Michael Roche, "Build Allied: 4 Steps to Increase Industrial Capacity and Resilience," *Defense News*, June 27, 2023.
[72] Manuela Tudosia, "ITAR-Related Obstacles to Exports," European Security and Defense, last modified October 13, 2022, https://euro-sd.com/2022/10/articles/27520/itar-related-obstacles-to-exports/.
[73] Office of the Secretary of Defense. n.d *Defense Technology Security Administration* May 12, 2025 https://www.dtsa.mil/SitePages/promoting-engagement/arms-transfer-policies-and-treaties.aspx.

The President also signed the *America First Trade Policy* Executive Order on January 20, 2025, that may shift policies related to export controls. While still early to determine how this executive order will affect export control policy, the order directs the Departments of Commerce and State to report to the President on eliminating any perceived loopholes in current export controls. This may result in greater enforcement of export controls, particularly those activities related to exports to China.[74]

To address these issues, DoD should prioritize targeted ITAR/EAR reforms in coordination with State and Commerce. These include:

- Expedited licensing for NATO and Indo-Pacific allies;
- Multinational R&D hubs with embedded personnel;
- Compliance cost-sharing and tax incentives;
- Increasing ITAR/EAR waivers for trusted allies to enable seamless co-production.

Although partnerships with countries like Australia, the United Kingdom, and other European nations are essential to maintaining a resilient defense industrial base, bureaucratic hurdles, especially secondary export restrictions, slow innovation and procurement. The current ITAR/EAR regulations often create unnecessary delays and barriers in technology transfers between allied nations.

3.3.3 Cost, Risk, Resources, and Ramifications of Inaction

Risks of inaction are acute: continued reliance on a limited domestic base will slow surge response, increase unit costs, and isolate the U.S. from allied innovation ecosystems. Without

[74] Akin, Gump, Strauss, Hauer, et al., "President Trump Places His Early Mark on Export Controls, Lexology, accessed May 12, 2025, https://www.lexology.com/library/detail.aspx?g=dfe5adcf-f54f-40f9-a207-67e049893aa3.

reform, critical aircraft programs could face avoidable production delays, interoperability gaps, and erosion of alliance cohesion. Moreover, adversaries like China and Russia will continue leveraging their centralized industrial models while red tape hinders U.S. and allied firms.

The cost of action, while significant in terms of policy reform, IT system upgrades, compliance streamlining, and bilateral negotiations, is outweighed by the strategic dividends of an expanded, interoperable industrial base. Key resource requirements include:

- Congressional appropriations for IT modernization and compliance cost relief;
- Staffing and capacity within the Departments of Defense, State, and Commerce to process collaborative licensing faster;
- Senior DoD leadership's commitment to embed "Build Allied" in acquisition guidance and incentives.

Availability, scalability, survivability, and maintainability improve when co-production with trusted allies becomes standard policy. It allows faster component substitution, distributed risk, broader innovation inputs, and less dependency on single-source bottlenecks.

3.4 Initiative 4: Capabilities and Infrastructure Modernization

Initiative four of the NDIS-IP targets the modernization of critical capabilities and infrastructure.[75] LOE 4.3 specifically aims to improve MRO&U operations, and the DoD's Regional Sustainment Framework (RSF) intends to achieve this through a globally connected, resilient ecosystem.[76]

[75] LaPlante, William A., *National Defense Industrial Strategy Implementation Plan for FY2025* (Washington, D.C.: Department of Defense, 2024), 42, https://www.businessdefense.gov/docs/ndis/NDIS%20Implementation%20Plan_Revised_03182025_508.pdf

[76] "Regional Sustainment Framework (RSF) FACT SHEET," Office of the Deputy Assistant Secretary of Defense, last accessed April 30, 2025,1, https://www.dau.edu/sites/default/files/2024-02/RSF%20INFO.pdf

Successful multinational aircraft R&D, like Airbus and the F-35 Joint Strike Fighter, demonstrate how international collaboration frameworks can serve as models for implementing RSF. These partnerships show that joint ventures grounded in shared governance, cost-sharing, and institutional trust can overcome financial, technical, and political barriers that no single nation can address alone. Applying these principles to MRO&U, the RSF can build a more integrated, resilient sustainment framework. Adapting these proven models to sustainment rather than R&D, the DoD can accelerate RSF implementation while strengthening interoperability, supply chain resilience, and allied partnerships.

While the RSF adopts a collaborative approach, it faces region-specific obstacles, especially in the Indo-Pacific, where the framework's implementation is focused. Key challenges include governance complexity, IP concerns, political risks around sovereignty tensions, export control restrictions, clearance requirements for "joint workforce development programs,"[77] physical and cyber security, lack of skilled workforce, regional regulatory compliances, and infrastructure adoption or expansion.[78] Although the NDIS-IP calls for non-financial incentives in the implementation of the RSF,[79] these alone are unlikely to overcome substantial investment barriers facing the industry.[80] Cost-sharing among the DoD, host nation, and private partners is essential to meeting the RSF's goals and building a sustainable sustainment framework in the region.

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[77] RSF Fact Sheet, 1.
[78] RAND Corporation, *Assembling and Supporting the F-35 Global Enterprise,* 2019; Sparaco, Pierre, *Airbus: A European Giant (*Minneapolis: Zenith Press, 2005).
[79] William A. LaPlante, Christopher J. Lowman, *2024 Regional Sustainment* Framework (Washington, D.C.: Department of Defense, 2024), 5, https://www.acq.osd.mil/asds/docs/RSF-9MAY24.pdf.
[80] Mathis, Karen Brune, "Permits Issued for $109 Million Boeing Facility at Cecil," Daily Record, March 15, 2022, https://www.jaxdailyrecord.com/news/2022/mar/15/permits-issued-for-dollar109-million-boeing-facility-at-cecil/. For example, Boeing's recent development of an MRO&U facility for the F/A and E/A-18 cost $109M, excluding the training and investment on capital, the RSF is asking for multiple internationally located facilities.

To address these challenges, the DoD should pursue near-term opportunities leveraging existing regional infrastructure and partnerships. One promising approach is integrating with host nation military MRO&U facilities that already operate similar platforms. However, not all partner nations in the region operate the same aircraft as the United States. An alternative path involves working with commercial MRO&U facilities distributed throughout the Indo-Pacific region.[81] Although integrating into these facilities proves useful as a starting point, the DoD lacks an opportunity to leverage the Indo-Pacific's economic and security desires.

Several Indo-Pacific nations including Thailand, Singapore, Malaysia, Vietnam, and the Philippines all express interest in becoming maintenance hubs for commercial aviation.[82] Their competitive advantages, such as low labor costs, a large workforce, and strategic geography, make them attractive partners.[83] The OUSD (A&S) can capitalize on this interest by incentivizing both global industry partners and regional governments to co-invest in MRO infrastructure. For host nations, additional incentives beyond the RSF include enhanced security, job creation, technical training, and the potential to develop aerospace industry clusters. For commercial firms, participation offers access to OUSD (A&S) sustainment contracts, reduced labor costs, compliant supply chain expansion, and long-term human capital development.

[81] Boeing has a facility in Singapore and Lockheed Martin directly approves third party facilities to perform MRO&U on its C-130J in Singapore and Malaysia.
[82] Basri Fahriza, Adibah Shuib, and Wan Mazlina Wan Mohamed, "Issues and Challenges of Aviation Maintenance Repair and Overhaul in Southeast Asia," in Proceedings of the International Conference on Industrial Engineering and Operations Management (Harbin, China: Malaysia Institute of Transportation, 2021), 473-475, https://www.ieomsociety.org/china2021/papers/213.pdf.
[83] Basri Fahriza, Adibah Shuib, and Wan Mazlina Wan Mohamed, "Issues and Challenges of Aviation Maintenance Repair and Overhaul in Southeast Asia," in Proceedings of the International Conference on Industrial Engineering and Operations Management (Harbin, China: Malaysia Institute of Transportation, 2021), 469, https://www.ieomsociety.org/china2021/papers/213.pdf

To fully realize these opportunities, the U.S. should expand beyond Enhanced Defense Cooperation Agreements [84] and pursue more permanent air bases in these countries. Establishing enduring U.S. air bases would strengthen deterrence, reinforce regional security, and provide a foundation for long-term sustainment operations. Also, the host nation will benefit from enhanced security and deterrence against Chinese aggression through U.S. presence, job creation, and training of its local aircraft workforce.[85] By assuming responsibility for technical training, the U.S. reduces the financial burden on host nations, ensure new technicians meet the Military Aviation Authority (MAA) standards, while strengthening international relationships with partner nations.

Also, numerous MRO&U facilities in the region are interconnected and will allow a more diversified supply chain, leveraging each nation's suppliers. This approach aligns with RSF objectives while accelerating sustainment and strengthening industrial partnerships.

To build on the previously outlined policy recommendations and support the objectives of LOE 4.3, the following additional recommendations are proposed:

1. The OUSD (A&S) should establish a permanent joint governance body, modeled on the successful F-35 Joint Program Office, to work with the RSF to integrate government stakeholders, coordinate shared development, manage IP agreements, mutual recognition of export licenses among key allies, and resolve disputes early. The RSF can focus on the complex requirements to establish MRO&U facilities

[84] Lariosa, Aaron-Matthew, "Philippine Air Base Gets U.S.-Funded Upgrade Under China Deterrence Plan," USNI News, January 29, 2024, https://news.usni.org/2024/01/29/philippine-air-base-gets-u-s-funded-upgrade-under-china-deterrence-plan.

[85] Fahriza, Basri, Adibah Shuib, and Wan Mazlina Wan Mohamed, "Issues and Challenges of Aviation Maintenance Repair and Overhaul in Southeast Asia," in Proceedings of the International Conference on Industrial Engineering and Operations Management (Harbin, China: Malaysia Institute of Transportation, 2021), 469, https://www.ieomsociety.org/china2021/papers/213.pdf. - Boeing estimations put the need for additional aviation technicians in the Indo-pacific at 60,000 by 2035.

through this approach. At the same time the governing body manages regulatory requirements, resulting in smoother joint ventures and fostering a sense of optimism about the future of aerospace innovation.

2. DoD should establish agreements with partners that exchange security and information sharing for strategic air basing locations while also enabling commercially run MRO&U facilities to operate out of these military installations.
3. OUSD (A&S) should incentivize suppliers to establish a local footprint through providing training and long-term part contracts for the local MRO&U facility.

The major costs of these policies for the U.S. government include the coordination and expenses associated with multinational oversight, as well as capital investment for establishing new basing locations or upgrading combined bases to meet security requirements. If the DoD cannot establish new basing locations due to cost or partner nation resistance, it must redirect investments to existing commercial and partner nation MRO&U facilities and accept the constraints of limited location options. Risks include potential information spillage, geopolitical friction over sovereignty and export controls, and funding delays if Congress fails to approve DoD budgets on time. Additional concerns include the strain on an already limited military force needed to staff each new base and the vulnerability of placing multiple MRO&U facilities within striking distance of China. Furthermore, the interoperability of regulatory standards between nations may complicate joint ventures, and the ability to scale these efforts will rely heavily on sustained partnerships with host nations.

3.5 Initiative 5: New Capabilities Using Flexible Pathways

The DoD successfully expanded the DIB and improved supply chain resilience, attracting more than 450 non-traditional defense contractors into the ecosystem with

Replicator-1.[86] The USAF's CCA program is also attempting to expand the DIB by attracting non-traditional defense firms, like Anduril Industries. Additionally, technical requirements for CCA Increment two will likely remain low to reduce barriers to entry and invite new applicants.[87] Although Initiative five and the CCA program have attracted new firms to the DIB and created flexible acquisition pathways for smaller Unmanned Aerial Systems (UAS), the defense aviation industry's crewed Air Dominance (AD) sector must also be strengthened.[88] Crewed AD platforms will continue to be relevant in the future as AI and autonomous technology are not yet fully operational. Thus, crewed AD production must also keep pace with the PRC. Some critics have argued that the current state of the DIB and supply chains, exorbitant costs, and politics all inhibit efforts to improve the crewed AD industry. [89] However, there are potential means to expand the DIB and supply chains while increasing crewed AD program frequency to create a competitive, innovative, and cost-effective market capable of keeping pace with the PRC.

To strengthen the AIB and outpace China's military advancements, policymakers should pursue the following recommendations:

1. Optimize CCA contracts to improve AD-related DIB and supply chains: In the near term, contracting several CCA firms is the most feasible way to reinvigorate the DIB, improve supply chain resilience, and provide an immediate counter to PRC modernization. Expanded CCA production signals consistent demand, fosters

[86] *The Replicator Initiative* (Washington, D.C.: Defense Innovation Unit, 2023), accessed April 20, 2025, https://www.diu.mil/replicator.
[87] "Air Force Futures Boss Leans Toward 'Low End' CCA in Next Increment," *Air & Space Forces Magazine*, accessed May 1, 2025, https://www.airandspaceforces.com/air-force-futures-boss-leans-toward-low-end-cca-in-next-increment/.
[88] *NDIS-IP,* p. 28.
[89] Thompson, Loren, "Five Reasons the Air Force's Digital Century Series Is Doomed to Failure," *Forbes*, September 24, 2019, accessed May 1, 2025, https://www.forbes.com/sites/lorenthompson/2019/09/24/five-reasons-the-air-forces-digital-century-series-is-doomed-to-failure/.

industry competition, reduces costs, creates surge capacity, and provides demand for redundant suppliers. In the long term, an improved DIB and supply chain may offer opportunities to increase AD program frequency. There are several risks and costs with this recommendation. Expanding CCA contracts could strain limited labor and production capacity, worsen supply chain bottlenecks, and introduce risks tied to immature technologies and integration challenges. Managing multiple vendors increases acquisition complexity, while budget instability could disrupt progress. Upfront costs for new production lines, testing, and integration remain high, and without enforced commonality, a more diverse fleet may increase long-term sustainment and training expenses.

2. Use CCA momentum to implement the Light Fighter Concept:[90] DIB improvements from the CCA program may enable more frequent production of simple fighters. As the U.S. shifts away from exquisite airframes, future designs should prioritize sensor fusion and modular adaptability over speed and maneuverability.[91] A lower-complexity LF design reduces development costs, shortens production timelines, and lowers barriers to entry for new firms. This increased competition would enhance cost control and build surge capacity into the industrial base. The LF advanced systems also use Modular Open Systems Architecture and can attract smaller technological firms. Flexible acquisition pathways like MTAs and OTAs can be used more often for systems than airframes,

[90] Hollings, Alex, "The Big Problem with the Air Force's 'Light Fighter' Concept," *Sandboxx News*, September 3, 2024, accessed April 20, 2025. https://www.sandboxx.us/news/the-big-problem-with-the-air-forces-light-fighter- concept/. USAF Chief of Staff General David Allvin proposed the LF idea recently, describing it as a less exquisite, standard fighter shell encapsulating an exquisite modular, tailorable mission system.
[91] Osborn, Kris, "Sensor Fusion: The Secret Sauce that Makes the F-35 Revolutionary," *The National Interest*, September 1, 2021, https://nationalinterest.org/blog/buzz/sensor-fusion-secret-sauce-makes-f-35-revolutionary-192873.

increasing acquisition speed and efficiency. The LF concept can also expedite production by reducing regulatory barriers. Once the LF program achieves initial FAA Flightworthiness Certification, subsequent iterations can maintain minimum flightworthiness requirements while advancing system lethality and survivability requirements. Lastly, a shared fighter shell with plug-and-play modular systems would reduce maintenance and training costs, improve interoperability, and support agile concepts in the Indo-Pacific.[92] This approach aligns affordability, speed, and joint force readiness while strengthening DIB resilience.

3. Use LF momentum to implement the Digital Century Series (DCS) concept: The consistent demand from the LF program will disrupt current industry models. Today, long program cycles shape the industry's structure and conduct by favoring extended operations and sustainment (O&S) contracts, which government agencies usually award on a sole-source basis. This approach minimizes competition, stifles innovation, and weakens cost controls.[93] As a result, the USAF spends about 70% of its budget on O&S. Increased program frequency has the potential to reverse this trend. It could reduce long-term O&S costs by having more frequent production cycles, spurring innovation, and accelerating R&D. However, increased program frequency also brings higher upfront development and production costs. Critics often cite these rising acquisition costs as a barrier to adopting a Digital Century Series approach.[94] Even so, sustained demand lowers barriers to entry,

[92] Hollings, "The Problem with the Air Force's 'Light Fighter' Concept," *Sandboxx News.*
[93] Hartley, Keith, *The Political Economy of Aerospace Industries: A Key Driver of Growth and International Competitiveness?* (Cheltenham, UK: Edward Elgar Publishing, 2014), p. 199. Augustine's Law states, that the individual cost of high-performance aircraft has grown by a factor of four every decade, forcing production concentration in richer countries within a smaller number of large prime contractors.
[94] Thompson, "Five Reasons the Air Force's Digital Century Series Is Doomed to Failure," *Forbes.*

encouraging more firms to compete for contracts. Greater competition strengthens cost control and innovation across the industrial base. The DoD must maintain a steady production tempo to capitalize on these benefits.

3.6 Initiative 6: Intellectual Property and Data Analysis

IP disputes in aerospace can be traced back to the Wright Brothers' "patent war" with competitors over airplane designs as they attempted to establish a monopoly over the nascent aircraft industry.[95] In recent years, disputes over IP rights between DoD and commercial firms have become a major obstacle to aviation innovation and procurement. Cautionary tales about DoD failing to adequately negotiate software IP rights in the original F-35 program or not anticipating IP implications when cancelling contractor maintenance for the C-17 are among the many lessons learned.[96]

These conflicts, centering on the government's demands for more extensive IP rights versus the private sector's desire to protect proprietary technologies, have led to significant friction across the AIB. "[The] aviation industry is highly competitive, and companies in this industry rely heavily on innovation to maintain their market position."[97] However, as DoD recovers from earlier mistakes, it has transitioned to fixating on obtaining broad control over contractor IP, typically by insisting on obtaining either Government Purpose Rights (GPR) or Unlimited Rights to patents, trade secrets, copyrights, and commercial data.

The government's desire to avoid vendor lock, enhance competition, and promote innovation by "unlocking" IP has resulted in counterproductive side effects in the defense

[95] "Intellectual Property Issues in the Aerospace Industries," accessed April 29, 2025, https://www.bcf.ca/en/thought-leadership/2021/intellectual-property-issues-in-the-aerospace-industrie.
[96] "Intellectual Property Fights Par for the Course in F-35 Program," accessed April 29, 2025, https://www.nationaldefensemagazine.org/articles/2016/9/8/intellectual-property-fights-par-for-the-course-in-f-35-program.
[97] "Protecting Innovation in Aerospace," Finnegan | Leading IP+ Law Firm, accessed April 29, 2025, https://www.finnegan.com/en/insights/articles/protecting-innovation-in-aerospace.html.

aerospace market, particularly for small and non-traditional businesses. “Faced with the choice of disclosing IP and putting future revenue streams at risk or walking away from certain government contracts, many of these companies will choose to protect their IP and commercial business.”[98]

Small business participation in the DIB has declined by more than 40% over the past decade and many companies have withheld their most valuable technologies from the government or refused to bid on certain work.[99] Between 2024 and 2025, the number of DIB firms stating they had avoided bidding on DoD contracts due to IP concerns rose from 21 to 36 percent, while 37 percent reported they had intentionally withheld core proprietary technologies from certain government proposals for fear of exposing IP to competitors.[100]

These trends threaten to relegate DoD to second-tier customer status, significantly undercutting efforts to foster competition and improve technology access at a time when Chinese aerospace innovation is on the rise. Many firms believe that DoD has developed “unrealistic expectations on IP rights” and must balance legitimate concerns with national security interests by taking a moderate approach “that gets the department what it needs and at the same time protects industry….”[101] This entails adopting more flexible IP practices, reducing regulatory uncertainty, and focusing on collaboration over control.

In addition to struggles over IP rights, AIB firms must contend with various malign cyber actors attempting to access proprietary data. Chinese hackers are known to have gained unauthorized access to sensitive contractor technologies for the F-22 and F-35, used to accelerate

[98] “2024_vital_signs_final.Pdf,” accessed April 29, 2025, https://www.ndia.org/-/media/sites/ndia/policy/vital-signs/2024/2024_vital_signs_final.pdf?download=1.
[99] Ibid
[100] “Vital Signs,” accessed April 29, 2025, https://www.ndia.org/policy/publications/vital-signs.
[101] “Intellectual Property Fights Par for the Course in F-35 Program,” accessed April 29, 2025, https://www.nationaldefensemagazine.org/articles/2016/9/8/intellectual-property-fights-par-for-the-course-in-f-35-program.

the PRC's own J-20 development program. In response, Zero-Trust Architecture (ZTA) and other cyber protocols based on the "never trust, always verify" principle are being deployed across the AIB to counter increasingly sophisticated intrusion attempts.[102]

The following IP and data protection recommendations will assist in balancing cost, competition, and resilience:

1. Reduce procurement requirements for Unlimited Rights and scope GPR to address disclosure of core IP to competitors during the competitive bidding process. This aligns better with commercial IP practices, easing some firms' hesitation in doing business with DoD.
2. Improve IP and data requirements planning before competitive bidding to ensure DoD has adequate access while defining how commercial proprietary information may be used, shared, or commercialized.
3. Continue to incorporate protocols such as Cybersecurity Maturity Model Certification (CMMC) and ZTA to enhance the aviation sector's resilience against cyber espionage.

4.0 Conclusion

The strength and resilience of the U.S. AIB are indispensable to maintaining American airpower superiority in an era marked by intensifying geopolitical competition and rapidly evolving technologies. This paper assessed the AIB through the lens of Porter's Diamond Model and aligned its strategic needs with the six initiatives of the National Defense Industrial Strategy Implementation Plan. The analysis highlighted enduring strengths and urgent vulnerabilities,

[102] National Institute of Standards and Technology. Zero Trust Architecture (NIST Special Publication 800-207). U.S. Department of Commerce. (2020).

ranging from critical workforce shortages and reliance on foreign materials to misaligned regulatory frameworks and insufficient industrial mobilization capacity.

While the NDIS-IP offers a strong framework for revitalizing the defense industrial base, it largely emphasizes ships, submarines, and munitions, with insufficient focus on the aircraft sector. This paper argues that the same principles must be deliberately applied to the AIB to ensure it is not left behind. Despite its unmatched technological foundation, the AIB remains constrained by outdated acquisition practices, fragmented policy execution, and underdeveloped mobilization infrastructure.

This paper provides a targeted series of policy reforms and recommendations to address these challenges, including embracing additive manufacturing, onshoring critical materials, enhancing allied industrial collaboration, and modernizing MRO&U infrastructure across global theaters. Sustained investments in workforce development, flexible acquisition authorities, and intellectual property protections must complement these actions to incentivize commercial participation without compromising national security.

The United States must also recalibrate its regulatory and procurement posture to better accommodate the realities of modern industrial collaboration. Shifting from a "Buy American" to a “Build Allied” approach, anchored in export control reform and multinational co-production, will expand capacity, enhance interoperability, and strengthen strategic alliances.

In sum, the future of U.S. air dominance depends on advanced platforms and the ecosystem that produces and sustains them. Through decisive implementation of the NDIS-IP, tailored specifically to the aircraft industry, the DoD can mitigate risk, accelerate innovation, and build an industrial base capable of meeting the demands of tomorrow’s fight.

Appendix 1: Artificial Intelligence

Artificial Intelligence (AI) is rapidly transforming the U.S. Aircraft Industrial Base (AIB), serving as a strategic accelerator across design, production, sustainment, and operations.[103] As both commercial and defense sectors increasingly adopt AI to enhance efficiency, adaptability, and readiness, the integration of intelligent tools has become essential to supporting the National Defense Strategy. AI is no longer an emerging technology but a foundational enabler of strategic competition, with wide-ranging implications for industrial resilience and national security.

Strategic Integration Across the AIB

AI is a key pillar of the National Defense Industrial Strategy Implementation Plan, particularly under Initiative 6, which emphasizes strengthening AI, data, and analytics ecosystems to enhance decision-making, supply chain visibility, and operational resilience across the defense industrial base.[104] Within the AIB, AI supports this directive by enabling predictive maintenance, logistics optimization, autonomous systems development, and digital design. Leading aerospace and defense firms have adopted AI to forecast parts demand, reduce repair cycles, and optimize mission systems.[105]

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[103] "(22) The Skys the Limit: How AI Is Revolutionizing the Aviation Industry | LinkedIn." https://www.linkedin.com/pulse/skys-limit-how-ai-revolutionizing-aviation-industry-kalea-texeira-uzzye/.
Abubakar, Mahmoud, Erioluwa Odunlami, Teyei Mangai, and Fadi Al-Turjman. "AI Application in the Aviation Sector," 52–55, 2022. https://doi.org/10.1109/AIoTCs58181.2022.00015.
"AI in the Sky: How Artificial Intelligence and Aviation Are Working Together." //interactive.aviationtoday.com/avionicsmagazine/may-june-2022/ai-in-the-sky-how-artificial-intelligence-and-aviation-are-working-together/.
Mackiewicz, Julia. "Top 5 Use Cases of AI in the Aviation Industry." *Addepto* (blog), January 15, 2025. https://addepto.com/blog/ai-in-the-aviation-industry-top-5-use-cases/.
[104] "National Defense Industrial Strategy Implementation Plan for FY2025," Department of Defense, 2024, 35.
[105] Samatha Renigunta. "Who Are the Leading Innovators in Aircraft Maintenance AI for the Aerospace and Defense Industry?" *Airforce Technology* (blog), December 13, 2023. https://www.airforce-technology.com/data-insights/innovators-ai-aircraft-maintenance-ai-aerospace-and-defense/.

Organizations are increasingly deploying AI tools across every phase of the aircraft lifecycle. These capabilities optimize traditional workflows and redefine how aircraft are conceived, manufactured, maintained, and operated. Table 1 illustrates how AI is integrated across key AIB functions, highlighting both operational benefits and national security impacts.

Table 1: Integration of AI Across the AIB[106]

AIB Function	AI Application	Benefit to the AIB	National Security Impact
Sustainment & Maintenance	Predictive analytics for part failures; AI-assisted troubleshooting	Reduces downtime, improves readiness	Increases aircraft availability during high-tempo operations
Production & Manufacturing	Additive manufacturing optimization; automated quality control	Shortens lead times, improves precision	Enables scalable surge capacity for wartime production
Supply Chain Resilience	Real-time logistics tracking; demand forecasting	Minimizes disruptions, increases transparency	Secures material flow under contested or degraded conditions

[106] "The Skys the Limit: How AI Is Revolutionizing the Aviation Industry | LinkedIn." https://www.linkedin.com/pulse/skys-limit-how-ai-revolutionizing-aviation-industry-kalea-texeira-uzzye/.
Administrator, Aurora. "Bridging the Gap Between Humans and Autonomy." Aurora Flight Sciences, June 15, 2022. https://www.aurora.aero/2022/06/15/bridging-the-gap-between-humans-and-autonomy/.
"AI in the Sky: How Artificial Intelligence and Aviation Are Working Together." //interactive.aviationtoday.com/avionicsmagazine/may-june-2022/ai-in-the-sky-how-artificial-intelligence-and-aviation-are-working-together/.
"AI in the Sky: How Artificial Intelligence and Aviation Are Working Together." //interactive.aviationtoday.com/avionicsmagazine/may-june-2022/ai-in-the-sky-how-artificial-intelligence-and-aviation-are-working-together/.
Cohen, Raphael, Nathan Chandler, Shira Efron, Bryan Frederick, Eugeniu Han, Kurt Klein, Forrest Morgan, Ashley Rhoades, Howard Shatz, and Yuliya Shokh. *The Future of Warfare in 2030: Project Overview and Conclusions*. RAND Corporation, 2020. https://doi.org/10.7249/RR2849.1.
General Atomics Aeronautical Systems Inc. "GA-ASI's Avenger Leads the Way in Autonomy and AI." https://www.ga-asi.com/ga-asi-avenger-leads-the-way-in-autonomy-and-ai.
Lockheed Martin. "Skunk Works® AI and Autonomy." https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunkworks-ai-autonomy.html.
Mackiewicz, Julia. "Top 5 Use Cases of AI in the Aviation Industry." *Addepto* (blog), January 15, 2025. https://addepto.com/blog/ai-in-the-aviation-industry-top-5-use-cases/.
Rashid, Adib Bin, and MD Ashfakul Karim Kausik. "AI Revolutionizing Industries Worldwide: A Comprehensive Overview of Its Diverse Applications." *Hybrid Advances* 7 (December 1, 2024): 100277. https://doi.org/10.1016/j.hybadv.2024.100277.
sjs371. "The Role of AI in Developing Resilient Supply Chains | GJIA." *Georgetown Journal of International Affairs* (blog), February 5, 2024. https://gjia.georgetown.edu/2024/02/05/the-role-of-ai-in-developing-resilient-supply-chains/.
"The United States Air Force's Focus on AI Research and Development," May 21, 2024. https://www.airmanmagazine.af.mil/Features/Display/Article/3776930/the-united-states-air-forces-focus-on-ai-research-and-development/http%3A%2F%2Fwww.airmanmagazine.af.mil%2FFeatures%2FDisplay%2FArticle%2F3776930%2Fthe-united-states-air-forces-focus-on-ai-research-and-development%2F.

Workforce Support & Training	AI-enabled maintenance assistants and translation tools	Augments low-density skilled labor pool	Mitigates workforce shortages and supports global partnerships
Platform Autonomy & Ops	Autonomy in airframes; AI-enabled flight systems	Enhances mission flexibility and force multiplication	Supports deterrence through asymmetric capabilities (e.g., Replicator)
Design & Prototyping	Generative design algorithms; AI-driven simulations	Accelerates development cycles	Keeps pace with adversaries' innovation timelines

Challenges and Risks

Despite its benefits, AI's transformative potential also introduces technical, regulatory, and ethical complexities. Many AI systems operate in non-deterministic ways, which challenge traditional certification and approval processes.[107] Regulatory inconsistencies across agencies, such as the FAA and DoD, and across allied nations further complicate deployment in multinational environments. Additionally, increased reliance on data and machine learning exposes the AIB to heightened cybersecurity and intellectual property risks. Table 2 summarizes these key challenges and outlines mitigation strategies critical to secure AI integration.

Table 2: Challenges and Mitigation Considerations[108]

Challenge	Description	Mitigation Strategy
Regulatory Complexity	Certification of AI systems under FAA, DoD, and international standards	Establish unified testing/evaluation frameworks
Cybersecurity and IP Protection	Increased exposure to adversarial attacks and data theft	Invest in zero-trust architectures and protected data layers

[107] Scientist, Sahin Ahmed, Data. "Building AI Agents That Don't Break: Why Security and Safety Can't Be Afterthoughts." *Medium* (blog), March 22, 2025. https://medium.com/@sahin.samia/building-ai-agents-that-dont-break-why-security-and-safety-can-t-be-afterthoughts-bd750152b345.

[108] "AI Seen As Means To Bridge MRO Workforce Gap, Attract Talent | Aviation Week Network." https://aviationweek.com/shows-events/mro-americas/ai-seen-means-bridge-mro-workforce-gap-attract-talent.
Azyus, Adryan, and Budhy Kurniawan. "Regulatory, Ethical, and Security Dimensions of AI in Aircraft Maintenance: A Framework for Assessing Harm." *Journal of Ecohumanism* 4 (January 2, 2025). https://doi.org/10.62754/joe.v4i1.6666.
"Cyber Resilience In Aerospace And Space: Failures And AI Solutions." https://www.forbes.com/councils/forbestechcouncil/2025/03/04/cyber-resilience-in-aerospace-and-space-lessons-from-incident-response-failures-and-ai-driven-solutions/.
"Navigating Regulatory Compliance in Aircraft Maintenance: MROs." https://blog.sourceonespares.com/navigating-regulatory-compliance-in-aircraft-maintenance-mros.

Workforce Readiness	Digital skills gap in maintenance, design, and analysis	Expand AI-focused training, DoD-industry educational pipelines
Partner Nation Integration	Inconsistent standards across allied maintenance environments	Promote AI-based translation/diagnostic tools, shared training
Ethical and Operational Risks	Black-box decision-making in critical systems	Ensure transparency, human-in-the-loop controls

Workforce Considerations

AI adoption in the AIB is highly dependent on the availability of a digitally skilled workforce. While AI can automate certain functions and support less experienced technicians, it cannot replace the need for sustained investment in human capital. Addressing the shortage of AI-literate engineers, maintainers, and analysts requires robust public-private partnerships, certification pathways, and targeted educational pipelines. Broader government-industry coordinated efforts are needed to align workforce development with AI readiness at scale. These efforts will be critical to sustaining U.S. airpower advantages.

Implications for National Security

As adversaries like China rapidly integrate AI into their defense strategies, particularly in autonomous platforms and data-driven warfare, the U.S. must accelerate AI integration across its own defense industrial base. The AIB's ability to scale, secure, and apply AI tools will shape its responsiveness in intensifying global threats. Ensuring industrial resilience in this environment means addressing workforce gaps, regulatory barriers, cybersecurity vulnerabilities, and intellectual property protection. These actions are not just about modernization; they are vital to preserving the U.S. military's decisive advantage and competitive edge in national security.

Appendix 2: Wargaming

Integrating the Aircraft Industry for Protracted Conflict Scenarios

The rising threat of peer or near-peer adversaries like China demands a more realistic approach to U.S. military wargaming, one that accounts for the industrial and logistical realities of a sustained high-intensity conflict. Current simulations often emphasize rapid, high-attrition scenarios without seriously modeling how the aircraft industry would reconstitute such losses. This oversight risks flawed assumptions that could undermine readiness and strategic planning.

Organizations like the Center for Strategic and International Studies (CSIS) report losing hundreds of U.S. tactical aircraft within weeks during wargames. Scenarios involving Taiwan, for example, project average losses of 283 aircraft in base cases and up to 484 in pessimistic outcomes.[109] Up to 90% of these losses happen while aircraft sit vulnerable on the ground, illustrating the vulnerability of forward-deployed assets.[110] Yet, these simulations frequently ignore the real-world timelines and constraints of replacing advanced airframes.

Unlike World War II, when thousands of bombers were built in a few years, manufacturers produced modern aircraft like the F-35 at a much slower rate, just 440 over nearly two decades.[111] The aircraft industry's dependence on civil-sector suppliers, a limited skilled labor force, and just-in-time manufacturing make surge capacity a serious concern. Moreover, planners rarely simulate contested logistics such as fuel, spare parts, and repair capabilities under attack, leading to unrealistic expectations of operational endurance.

[109] Mark Cancian, Matthew Cancian, and Eric Heginbotham, "The First Battle of the Next War" (CSIS International Security Program, January 2023), 102, https://www.csis.org/analysis/first-battle-next-war-wargaming-chinese-invasion-taiwan.
[110] Cancian, Cancian, and Heginbotham, 102.
[111] Adam Saxton et al., "Industrial Mobilization: Assessing Surge Capabilities, Wartime Risk, and System Brittleness," n.d., 22.

To correct this, planners must redesign wargames to incorporate data on reconstitution timelines, degraded maintenance environments, contested logistics, and defense industrial base (DIB) limitations. Modelers should also include emerging technologies like Next Generation Air Dominance (NGAD), collaborative combat aircraft (CCA), and drones in simulations to accurately assess the suitability and feasibility of substitutes.

Equally important is integrating the aircraft industry into the wargaming process itself. Effective simulation of long-term air operations requires participation from the defense, civil aviation, logistics, and maintenance-repair-overhaul (MRO) sectors. These stakeholders bring critical insights on production cycles, supply chain bottlenecks, and technological development timelines. Their input allows strategic planners to assess force resilience and identify potential shortfalls in wartime production more accurately.

Establishing a structured feedback loop between wargames and the aircraft industry is essential. Defense organizations must share secure, actionable data on attrition rates, platform survivability, and potential substitutes. In turn, the industry can use this information to adjust investments in tooling, workforce scaling, and surge-readiness measures. Defense leaders gain a more grounded understanding of what industry can realistically deliver under sustained high attrition conflict.

Without these changes, U.S. wargames will underestimate the time, resources, and coordination needed to regenerate combat power in a prolonged conflict. Incorporating industrial realities into strategic simulations is not just prudent, it's necessary for maintaining credible deterrence and ensuring the U.S. retains air superiority in any future Indo-Pacific contingency.

Appendix 3: Case Study – U.S.-Mexico Aerospace Industrial Cooperation

Continued U.S. air superiority is dependent on strategic alliances that bolster its defense industrial base and U.S aircraft manufacturing capacity. Demonstrating the value of "Build Allied" partnerships, Mexico has emerged as a critical partner ensuring the resilience, efficiency, and competitiveness of the U.S. aerospace supply chain. The Mexican aerospace industry offers several key advantages, including geographic proximity, competitive labor costs, a highly skilled workforce, and an advanced manufacturing ecosystem with over 300 aerospace facilities. This partnership, anchored by agreements such as the United States-Mexico-Canada Agreement (USMCA) and supported by decades of cooperation, provides the United States with secure and agile access to essential aircraft components such as fuselages, engines, and electronic systems.[112]

From a strategic perspective, strengthening and expanding this alliance allows the United States to diversify supply chains against global risks, increase rapid response capabilities in times of conflict, and maintain technological leadership. However, this growing interdependence also presents challenges, including vulnerabilities to trade tensions, cybersecurity threats, and political fluctuations. Addressing these risks necessitates specific "Build Allied" U.S.-Mexico policies promoting nearshoring, joint investments in infrastructure and talent development, and deeper cybersecurity and intellectual property standards integration.

Employing the U.S.-Mexico "Build Allied" policy approach would strengthen the U.S.-Mexico aerospace supply chain through coordinated industrial policy, infrastructure investment, technology development, and regulatory alignment. This approach would also mitigate geopolitical, economic, and logistical risks while ensuring uninterrupted access to mission-

[112] Jorge Saldaña, "Aerospace Industry Seeks Collaboration with the UK," MEXICONOW, July 19, 2023, https://mexico-now.com/aerospace-industry-seeks-collaboration-with-the-uk/.

critical aerospace components.[113] Key policy pillars should include promoting nearshoring and regional diversification by incentivizing U.S. defense contractors to expand sourcing from Mexican suppliers, thereby reducing reliance on distant or potentially unreliable markets.[114] Additionally, improving cross-border infrastructure by upgrading customs procedures, border logistics corridors, and digital trade documentation systems is essential to reduce delivery times and enhance supply chain visibility.[115]

Deepening technological integration through the establishment of binational R&D centers focused on aerospace innovation, digital twin technologies, and additive manufacturing is also crucial.[116] Securing the supply chain through bilateral cybersecurity standards, investment in physical site protection, and the development of mechanisms to deter theft and sabotage is another critical component.[117] Aligning workforce development through STEM-focused joint academic programs, vocational training partnerships, and mutual recognition of certifications across both countries is necessary to support these efforts.[118]

Implementation challenges such as economic asymmetries, political changes, and nationalistic policies may impede long-term cooperation. U.S. domestic protectionism and Mexican regulatory instability could complicate defense outsourcing. Therefore, institutional continuity and mechanisms such as the U.S.-Mexico High-Level Economic Dialogue must be

[113] "Lizcano, Luis. 'Industry Update: The Mexican Aerospace Sector and Its Role in the U.S. Defense Supply Chain.' *FEMIA Bulletin*, 2024.," n.d.
[114] Felippo, Agustín. *Regional Value Chains and Nearshoring in North America: Strategic Opportunities for Mexico*. Inter-American Development Bank, 2022.," n.d.
[115] Glickman, Theodore S. 'Securing Aerospace Supply Chains: A Physical and Cybersecurity Perspective.' *George Washington University Policy Briefs*, 2023.," n.d.
[116] López Torres, Citlali. 'The Rise of Mexico's Aerospace Industry and Its Global Appeal.' Universidad Autónoma de Aguascalientes, 2023.," n.d.
[117] U.S. Department of Defense. *Securing Defense-Critical Supply Chains*. Office of Industrial Policy, 2023.," n.d.
[118] Huang, Hangzhou. 'Talent Development and Innovation in Industrial Ecosystems.' Institute of China Innovation and Entrepreneurship Education, 2023.," n.d.

reinforced to ensure policy stability and strategic alignment.[119] The expected outcomes of these efforts include a fortified aerospace corridor between the United States and Mexico, which will reduce strategic vulnerabilities, enhance production agility, and increase deterrence capacity. By investing in shared infrastructure, talent, and innovation, the U.S. will strengthen its defense supply chain resilience and maintain its technological edge in aerospace warfare.[120]

Expanding aerospace industrial collaboration with Mexico is not merely a convenient option; it is a strategic imperative to ensure that the U.S. defense aircraft industrial base remains resilient, competitive, and capable of sustaining air superiority in an increasingly contested global environment. A "Build Allied" policy approach that recognizes Mexico as a commercial ally and strategic manufacturing partner of the U.S. defense industrial base will deepen the bilateral industrial integration essential to securing America's air dominance into the future.

[119] Joel Nicholson, "Policy Continuity and Investment in U.S.-Mexico Aerospace Integration," Florida State University & Gonzaga University, 2024.," n.d.
[120] Shivakumar, Sujai. "Renewing American Innovation: Strategic Industrial Policy and the Aerospace Sector,". Center for Strategic and International Studies (CSIS), 2022.," n.d.