EXAMINING THE UNITED STATES AIR FORCE FIGHTER AIRCRAFT SUPPLY CHAIN: HOW NATIONAL SECURITY, BUDGETING, AND MANPOWER CHALLENGES IMPACT MISSION CAPABILITY

Ciara C. WETZLER, Robert O. WALTON

*Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA

This study examines how the COVID-19 pandemic severely disrupted the United States Air Force (USAF) supply chain, particularly concerning fighter aircraft, leading to further reductions in mission capability (MC) rates. Global delays and shortages in critical components and materials directly impair the Air Force's ability to respond to national security threats and maintain strategic deterrence. This disruption also strained the Department of Defense's (DoD) sustainment budget and manpower requirements. This research examines solutions the Air Force is exploring to combat supply chain disruptions, such as Conditions-Based Maintenance (CBM+) and Quality Function Deployment (QFD), to increase mission capability rates and relieve long-standing issues regarding manpower and budgeting constraints. These challenges highlight the urgent need to modernize supply chain systems, adopt long-term, flexible budgeting, and strengthen industry partnerships to improve readiness and ensure the timely delivery of critical fighter aircraft components during disruptions.

Key words: *supply chain, national security, budget, mission capability, manpower, fighter aircraft, and pandemic*

1. INTRODUCTION

The United States Air Force (USAF) is known around the globe for its air superiority due to the evolution of aircraft weapon systems (Brown: 2020). United States (U.S.) fighter aircraft are among the many airframes advancing through the skies, but remain the only weapons that dominate it, at least for now. Unfortunately, the fighter fleet struggles to stay *mission-ready*, as proven by low mission capability (MC) rates (Leone: 2021). Evidence following the COVID-19 Pandemic indicates that the military was already

facing further exacerbated challenges in maintaining MC rate standards (Leone: 2021). The Department of Defense (DoD) anticipated pandemic impacts to depot maintenance and supply chain operations; therefore, appropriated $475 million through the Coronavirus Aid, Relief, and Economic Security Act (CARES) Act to the U.S. Air Force in March 2020, see Figure 1 (GAO: 2021).

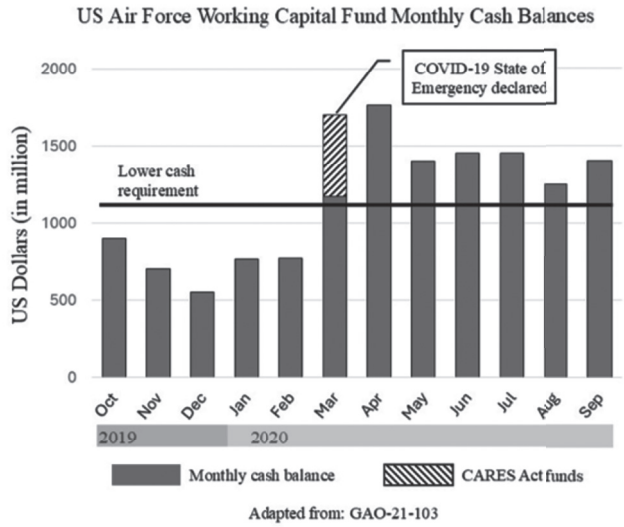

Fig.1 US Air Force working capital fund monthly cash balances

Despite this increase to the Air Force's Working Capital Fund (WCF), the depots were still unable to support MC rates, flying hour programs, and produce anticipated revenues. The Air Force reported during fiscal year (FY) 2020 approximately $355 million in maintenance and supply chain losses, which its customers covered in the form of rate surcharges (GAO: 2021). This strain on the USAF supply chain creates a concern for national security, sustainment budgeting, and fulfilling manpower requirements, highlighting the need to prioritize future logistics and maintenance operations (Mattis: 2018). This situation has profound implications for operational readiness and the Air Force's ability to respond to international conflict. Central to these challenges are the aging fleets of fighter aircraft (Losey: 2019). As aircraft age, complex and costly maintenance requirements increase, further straining financial budgets, part availability, and manpower skills. In recent years, the Air Force has overhauled its deployment operations to focus on the near-peer

war with countries such as China, North Korea, and Russia, which has placed pressure on the advancement of aircraft and training (Mattis: 2018). This research analyzes the Air Force's supply chain management system and its current strategies and efforts to mitigate these problems among fighter fleets, including modernization initiatives and process improvements to enhance mission capability and reinforce national security.

To set the stage on the scale of the problem, the F-22 *Raptor* is one of the newest Air Force fighter aircraft and entered service in 2005. From 2011 through 2019, the aircraft did not meet its annual availability or MC rate goals, with both availability and MC rates decreasing over this period (GAO:2020). The Operating and Support (O&S) costs for the F-22 were $13.27 million per aircraft in 2018. With maintenance costs account for $8.75 million (54 percent) of the total costs.

2. AIRCRAFT AGE AND UNSUSTAINABLE MAINTENANCE BURDEN

Today's fighter aircraft fleets reflect decades of technological innovation and aircraft evolution, dating back to World War I and II with icons such as the P-51 Mustang, to current modern stealth fighters like the F-22 Raptor and F-35 Lightning II (Linden: 2004, Shklarsky & Shamir: 2023) However, as the fleets begin to age without timely replacements, these advancements struggle to remain sustainable. Mission Capability rates have perpetually experienced rate drops, partly due to part shortages, but mostly impacted by budgeting constraints and aircraft age. The DoD is concerned with affordability surrounding sustainment costs, new aircraft procurement, and modernization, which is currently totaling approximately $23 million yearly (GAO: 2023).

According to the Government Accountability Office, most Air Force and Navy aircraft failed to meet MC rates between the years FY 2011- FY 2021, with the primary causes being maintenance delays and part availability. Out of the six Air Force fighters reviewed, none of them met MC rate goals in 2020 or 2021 (GAO: 2022). The COVID-19 pandemic further exacerbated existing supply chain and sustainment issues by disrupting supplier operations, delaying transportation of critical components, and limiting depot throughput due to manpower restrictions (GAO: 2021). As the Air Force continues to operate fourth-generation fighters beyond their intended service life, these issues will further create operational risk and threaten long-term fleet readiness.

2.1. Mission capability rates and flying hour programs

Mission capability rates established by the U.S. Air Combat Command (ACC) serve as key metric indicators for assessing the readiness of combat aircraft fleets within the U.S. Air Force (Leone: 2021). Maintenance squadrons utilize these metrics to monitor and report aircraft status, categorizing them as mission-capable or non-mission-capable based on maintenance needs (Leone: 2021). Through this data, maintainers can identify trends, prioritize repairs, and allocate resources effectively, ensuring that aircraft are maintained to the highest standards and ready to respond to operational demands. Unfortunately, this data cannot solve the current issue of a rapidly aging fleet and a bureaucratic supply chain system, especially regarding fourth and fifth-generation fighter jets such as the F-15, F-16, F-22, and F-35.

Reported MC rates over the last 12 years have proven that aircraft readiness is steadily decreasing each year (Cohen & Losey: 2022). From 2012 to 2018, there was a 7.93% decrease in MC rates across the Department of the Air Forces' 5,413 aircraft (Losey: 2019). The ACC MC rate standard is typically 75% or higher, and in 2020, most of the fighter aircraft fleets reported MC rates between 60-70%, remaining starkly below the standard (Leone: 2021). These rates raise national security and operational readiness concerns and impact the day-to-day operations supporting the bases' flying hour program (FHP) (Losey: 2019). Major Commands (MAJCOMs) create the requirements for FHPs based on the Air Force Flying Hour Model (AFFHM), which is outlined in the Air Force Instruction (AFI) 11-102, *Flying Hour Program Management.* These flight hours are critical for pilots to ensure they meet core tasks in their assigned airframe and are approved for downrange missions (Mills et al.: 2018). The Air Force's top priority is supporting the downrange mission; therefore, all mission-capable fighter aircraft are allocated for deployment operations. Most non-mission capable aircraft remain to meet home station needs, creating a difficult challenge for aircraft maintenance personnel directly responsible for fixing the jets and supporting the FHP (Losey: 2019). This unfortunate cycle has long been remedied through the experience of seasoned aircraft maintainers creating workarounds to keep generating aircraft sorties, which is not a sustainable solution (Losey: 2019). As the aging fleet continues to pose challenges for improving mission capability rates, the supply chain management system that supports it is equally outdated.

2.2. Challenges with supply chain, maintenance depots, and aging aircraft

The USAF's supply chain management system is at the core of keeping fighter aircraft operationally ready for down-range and home station requirements. Like many others, the military supply chain system comprises multiple nodes that work together to ensure non-mission-capable aircraft are swiftly repaired and returned to service. In addition to controlling aircraft parts, the Air Force's supply chain system manages many other vital parts, equipment, and weapons needed for base, deployment, transportation, and support operations.

The first step in the supply chain begins at the base level when aircraft maintenance personnel identify a broken part, initiating the repair process by documenting the issue and requesting a replacement through the Materiel Management flight. The Materiel Management flight, commonly called *supply*, is primarily responsible for assessing and managing most of the supply chain (Redfern: 2021). The Materiel Management flight consists of multiple sections mainly responsible for supporting maintenance operations, managing assets, and providing customer service (172nd Airlift Wing: 2024). If the part is available, aircraft maintenance will turn the damaged part into the Aircraft Part Store (APS) section, where a one-for-one swap is accomplished. This repair level is called *base* or *intermediate maintenance* (Keating: 2019). If the part is unavailable at the base level, an order is submitted with a designated level of importance, which signals to the item manager at the maintenance depot how urgent the part is for mission capability. If an aircraft is unable to fly or is deemed non-mission capable, a Mission Impaired Currently Awaiting Part (MICAP) alert is placed on the part to increase resupply priority. The maintenance depots are larger warehouses that maintain extensive inventories for complex repairs and provide scheduled aircraft maintenance to ensure the aircraft remains safe for flight (Keating: 2018). Unfortunately, due to their backlog, depots are the primary hurdle for most supply chain challenges.

The aging of many aircraft, particularly fourth-generation fighters like the F-15, has directly correlated to an increase in unscheduled depot-level repairs or a high demand for MICAP parts that depots cannot fulfill (Keating: 2018). The fleets in service were not intended to operate for such extended periods, so spare parts demand was not projected. The introduction of newer fighter jets, such as the F-35, was created to replace some of the fourth-generation fighters;

however, with spare part shortages and insufficient supply chains to support repair demands, the F-35 will not be able to completely replace fourth-generation fighters anytime soon (Husseini: 2019). Despite the introduction of the first F-35 models in the early 2000s, replacing older combat aircraft like the A-10 and F-15 has seen minimal progress. This stagnation is primarily attributed to an unsustainable supply chain, along with significant challenges related to budgeting and manpower shortages. These factors have compounded the Air Force's difficulties in maintaining operational readiness and fulfilling its strategic objectives.

2.3. Enduring budgeting issues

The Air Force's budget deficits are longstanding concerns that have been acknowledged

for some time. Sustainment budget concerns can be traced back to the establishment of the Air Force as an independent branch on September 18, 1947, just after World War II (Linden: 2004). As personnel were disbanded, many aircraft were designated *out of service* due to inadequate maintenance and reduced funding. This led to fewer aircraft being delivered to replace aging or non-functional units (Linden: 2004). This cycle of downsizing non-mission-capable aircraft has repeated itself multiple times since 1947.

Most recently, the Air Force's available fleet has dropped below 5,000 aircraft, which poses a concern for national security compared to its highest point of 26,104 active aircraft in 1956 (Losey: 2024). While the fleet's age has been used as an excuse for decommissioning aircraft over the years, so has the sustainment budget to keep these older fleets in MC status. Combat aircraft such as the F-15 and the A-10 cost more to sustain or replace than current funding levels allow due to the high cost of obtaining parts. Most recently, to combat the cost of supporting an aging fleet, Congress approved the purchase of the Boeing F-15EX model to retire the legacy F-15C/D models. This jet is an updated model of the current F-15C/D airframes while maintaining approximately 70% of the parts from the original design. This should help to reduce the overall supply chain cost to support the new model. However, the F-15EX costs more to produce per aircraft than to continue modifying the legacy models or purchasing more fifth-generation aircraft (Venable: 2021). Without harnessing the capability of flying in combat, the expected cost of a new F-15EX is estimated to be $87.7 million (Venable: 2021). Once the necessary equipment is added to prepare the airframe for combat, the total cost for each aircraft reaches approximately $102 million, making it, on average, 30% more expensive

than each F-35A, which costs $77.9 million per unit (Venable: 2021). Following the passage of the Financial Responsibility Act in 2023 (U.S. Chamber Staff: 2023), Air Force leaders faced difficult decisions: either maintain the aging aircraft over 50 years old or retire them and prioritize new fifth-generation models (Losey: 2024). By fiscal year 2025, the Air Force plans to retire 250 aircraft, including the older F-15 models and the A-10 (Losey: 2024). With this spending cap, the Air Force removed five F-15EX's and five F-35A's from its budget for fiscal year 2025 in efforts to reallocate funding towards the development of future airframes, specifically the Next Generation Air Dominance program, which will focus on the integration of artificial intelligence and advancing capabilities in future combat aircraft (Losey: 2024). The Financial Responsibility Act will compel the Air Force to prioritize investments in aircraft programs that will prepare the DoD for its focus on future conflicts.

The Air Force has evolved in many ways since its creation. Not only have the aircraft requirements changed and advanced, but so has the training of the personnel, specifically, the maintenance and logistics personnel who directly support and repair the fighter fleets across the globe. Following the publication of the 2018 National Defense Strategy (NDS), the Air Force's mission shifted to near-peer adversaries such as China and Russia; this shift established a renewed militant mindset for the Joint Force, which targets the importance of logistics and sustainment (Mattis: 2018).

2.4. Manpower and skillset concerns

Retired General Jim Mattis, who served as the United States Secretary of Defense from 2017 to 2019, stated in the NDS that the "backlog of deferred readiness, procurement, and modernization readiness" needed to be addressed and described key capabilities the Joint Force would improve upon over the coming years (Mattis: 2018, p. 6). This is where the idea of *adaptive basing* blossomed, currently known as Agile Combat Employment (ACE) (Cochran, et al.: 2023). To overcome adversaries in future conflicts, the Joint Force has restructured its deployment framework to support a more agile model capable of dispersing and rapidly regenerating forces across all domains, even under attack (Mattis: 2018). The ACE initiative and the directive to *accelerate change or lose,* by the previous Chief of Staff of the Air Force, General Charles Q. Brown Jr. (Brown: 2020, p. 3), prompted the Air Force to create a new concept termed *multi-capable Airmen* (MCA) (Cochran, et al.: 2023). Essentially, Airmen are not

only expected to be fully trained in their specific career field but also skilled in other vital tasks such as logistics, refueling, air and ground transportation, and agile combat tactics in contested environments (Cochran, et al.: 2023). Although implementing MCA intends to refine expeditionary combat skills, it poses an overarching concern for overextending maintenance and logistics Airmen (Cochran, et al.: 2023).

Aircraft maintenance is a specialized field that requires years of training to master "the launch, recovery, maintenance, and sustainment of aircraft supporting aircrew training operations while also operating and sustaining other essential aircraft support equipment" (Douglas, et al.: 2024, p. 5). The Air Force is already battling a shortage of skilled and experienced maintainers to tackle the growing issues of improving mission capability rates (Losey: 2019). These Airmen must manage the pressure of learning new skills beyond their expertise while continuing their regular duties. Implementing the MCA construct will provide numerous benefits to the force; however, it also entails a compromise for both the organization and the individuals involved, mainly regarding proficiency, development, and experience (Cochran, et al.: 2023). Without refocusing on retention and technical training, particularly in the aircraft maintenance career field, the MC rates will continue to suffer and plummet below the standard level, thus contributing to a further decline in national security.

2.5. COVID-19 effects on supply chain operations

While enhancing mission capability rates remains a systemic challenge for the USAF, the COVID-19 pandemic exacerbated these difficulties within the supply chain (Boatman: 2023). This disruption resulted in substantial delays in delivering essential parts and materials, hampering maintenance efforts and leaving many aircraft grounded (Pecho: 2023). The U.S. Senate was informed through a supply chain risk report that the unpredicted impact of COVID-19 on supply chains weakened national security (Korkmaz: 2024). Reliance on outside countries, including the U.S. adversary China, for essential materials, raised concerns about the Department of Defense's ability to advance competitively and strategically (Korkmaz: 2024). For example, research following the origins of one million spare parts in 2011 uncovered that 70% of these parts were being manufactured in China (Korkmaz: 2024). Outsourcing materials has shown that numerous subcontractors are producing low-quality products that fail to meet the minimum design standards for

aircraft, particularly the F-35A (Korkmaz: 2024). This forces the defense industry to rely on one or two companies to source approved materials, imposing significant manufacturing limitations (Korkmaz: 2024).

The Aerospace Industries Association reported that COVID-19 led to the loss of 55,700 positions within the defense supply chain, compounding the workforce issues at maintenance depots, primarily staffed by government civilians, which faced severe manpower shortages due to health restrictions and illness. These shortages slowed down repair processes, making it increasingly difficult for depots and contractors to maintain production rates and fulfill contract obligations. For example, Lockheed Martin, the contractor for the F-35A, responded to COVID-19 by cutting production and adjusting work schedules to prioritize the health and safety of its employees (Tadjdeh: 2020). Lockheed Martin funded approximately $750 million following the shutdowns to small businesses in their network in hopes of stabilizing the supply chain through this reduction in manufacturing (Tadjdeh: 2020).

Moreover, flying hour programs experienced a decline in training opportunities as access to operational aircraft was restricted, directly impacting pilots' readiness and proficiency (Losey: 2021). This combination of material scarcity and manpower challenges undermined the effectiveness of defense projects and highlighted critical vulnerabilities in the supply chain that threaten national security (Douglas et al.: 2024). In response, military leaders are evaluating these significant shortcomings and exploring innovative projects and new processes to reduce costs, improve repair timelines, address parts shortages, and ultimately enhance Airmen's quality of life.

2.6. Modernization and advancement initiatives

The U.S. Air Force is actively pursuing innovative initiatives to combat their aging fleet through decreasing maintenance repair times and associated costs, improving supply chains, and strengthening national security, all while prioritizing the quality of life for Airmen. Among these initiatives are concepts such as Conditions-Based Maintenance (CBM+), Quality Function Deployment (QFD), and the establishment of the Tesseract office. Condition-Based Maintenance Plus (CBM+) leverages data analytics and advanced technologies to monitor the real-time health of aircraft systems (Mirnenko et al.: 2020). By using sensors and tracking data, the Air Force can predict maintenance needs before failures occur, allowing for timely interventions that

minimize downtime (Hardin: 2023). This proactive approach improves mission capability by ensuring aircraft are ready for deployment and reduces costs associated with unnecessary repairs and parts replacements.

In addition to CBM+, the Air Force is implementing QFD to better align maintenance strategies with the needs of operational units. Quality Function Deployment focuses on understanding customer requirements and translating them into actionable maintenance and logistics solutions (Tsarouhas & Makrygianni: 2017). By prioritizing user input, the Air Force can develop more effective processes through a mathematical approach that enhances the efficiency of supply chains and reduces lead times for critical parts (Tsarouhas & Makrygianni: 2017). Furthermore, establishing the Tesseract office signifies a commitment to innovative problem-solving and agile responses to current challenges. Tesseract was established to foster rapid experimentation and development, focusing on identifying and implementing cutting-edge technologies and methodologies, particularly in maintenance, logistics, and supply chain management (Duvall: 2022). By leveraging advanced data analytics, artificial intelligence, and modern engineering practices, the Tesseract Office aims to streamline processes, reduce repair times, and ultimately improve mission capability. This initiative is part of the Air Force's broader effort to overcome emerging challenges by consulting lower-level Airmen and harnessing their innovative ideas (Duvall: 2022).

These initiatives collectively aim to combat the challenges posed by the pandemic, such as supply chain disruptions and staffing shortages, by fostering a culture of continuous improvement and agility within the Air Force. By streamlining maintenance processes and enhancing the quality of life for Airmen, these programs ensure that the Air Force remains well-equipped to meet current and future national security demands. The combination of predictive maintenance, user-centered design, and innovative organizational structures positions the Air Force to enhance its MC rates and resilience.

3. DISCUSSION

To effectively address the ongoing supply chain challenges facing the U.S. Air Force, it is essential to implement a comprehensive approach that targets both immediate and long-term resilience. The first critical step is to support the modernization of the USAF supply chain systems. This can be achieved by advocating for accelerating investments in advanced, resilient, and adaptive technologies, such as artificial intelligence (AI),

machine learning, and predictive analytics. These technologies can help the Air Force predict and manage supply chain disruptions before they escalate, enhancing the ability to respond quickly to unforeseen delays and shortages. Additionally, integrating real-time tracking systems and blockchain for transparency and accountability can ensure critical components are delivered on time and with minimal errors. The USAF must collaborate with technologists, logistics experts, and defense contractors to prioritize the development of such systems, ensuring the Air Force remains agile and capable of maintaining operational readiness in the face of global disruptions like the COVID-19 pandemic. By investing in these technologies, the USAF will be better prepared to face future crises without compromising mission capability.

Simultaneously, the Department of Defense (DoD) must adopt long-term budget flexibility and sustainability to better absorb the financial strain caused by supply chain disruptions. Traditional budgeting models have proven insufficient in addressing the unpredictable nature of global crises, as seen during the pandemic. To ensure that the USAF can maintain readiness despite external challenges, the DoD should explore implementing flexible, adaptive budgeting mechanisms that allow for rapid reallocation of resources when unexpected supply chain issues arise. This could involve creating contingency funds or adjusting allocations based on real-time data that reflects the impact of supply chain disruptions. Moreover, the DoD should ensure that its budgeting approach accounts for the costs of maintaining aging aircraft and expanding the life cycles of critical components so that these factors do not diminish mission capability in times of need. Through more dynamic budgeting, the USAF could remain operational even during supply chain instability, supporting both short-term needs and long-term sustainability.

Another key initiative is to enhance collaboration with industry partners to address vulnerabilities in the USAF's supply chain. The pandemic underscored the importance of private-sector collaboration in mitigating supply shortages and delays. The USAF must work closely with defense contractors, manufacturers, and other stakeholders to co-develop innovative solutions that improve supply chain resilience. For example, partnerships with private companies specializing in materials science or logistics can help the USAF access cutting-edge solutions that streamline procurement processes, reduce lead times, and ensure the availability of critical components. By fostering a more collaborative

environment, the USAF can leverage the expertise and capabilities of the private sector, ensuring that components are delivered more efficiently and at scale, even during global disruptions. Additionally, joint ventures and information-sharing initiatives between military and industry partners can improve communication, forecasting, and responsiveness, allowing for a more agile and proactive supply chain system.

Together, these actions form a comprehensive strategy for enhancing the USAF's operational effectiveness in the face of future challenges. By modernizing the supply chain with advanced technologies, adopting flexible budgeting practices, and fostering stronger industry collaborations, the USAF can maintain its mission capability rates and ensure it is well-prepared to respond to national security threats. These initiatives will not only help mitigate the effects of past disruptions but also create a more resilient, sustainable defense infrastructure that can endure future global crises with minimal impact on readiness.

4. CONCLUSION

Examining the U.S. Air Force supply chain reveals critical implications that mission capability has on national security, budgetary constraints, and manpower deficiencies. The primary challenges are an aging fleet and an unreliable supply chain system. Furthermore, the COVID-19 pandemic highlighted these vulnerabilities, resulting in significant delays in spare parts deliveries, loss of crucial positions, and heightened operational readiness concerns. If the Air Force fails to establish an effective supply chain, national security concerns will be profound, even with prioritizing aircraft modernization efforts. The evolution of modern-day warfare requires an agile and responsive supply chain capable of adapting to new threats and challenges.

Addressing these interconnected issues will require a comprehensive advancement that includes investing in new technologies, streamlining supply chain processes, and enhancing the training and retention of skilled personnel. Initiatives like *Agile Combat Employment* and the development of *multi-capable Airmen* reflect the Air Force's commitment to adapt to future conflicts. However, it is crucial to balance these innovative strategies with the need for specialized training and support for maintenance and logistics personnel. Initiatives such as CBM+, QFD, and Tesseract are expected to assist the Air Force in overcoming these obstacles. Without a renewed focus, the USAF risks further declining mission capability rates, compromising its

expeditionary response, national budget, and manpower capabilities during complex global conflicts.

For future research, these findings should be substantiated using primary data obtained from stakeholders, such as depot commanders, industry partners, and maintenance personnel.

Conflict of Interest Statement: The authors declare no conflict of interest.

Data Access Statement: No data were generated or analyzed in this study.

Funding Statement: This research received no external funding.

REFERENCES

[1] 172nd Airlift Wing. (2024). *Logistics Readiness Squadron.* 172nd Airlift Wing. https://www.172aw.ang.af.mil/About-Us/Fact-Sheets/Display/Article/449309/#:~:text=MATERIEL%20MANAGEMENT%20FLIGHT%20%28LGRM%29%20The%20Materiel%20Management%20Flight

[2] Boatman, M., Mapp, J., Olsen, N., & Szatkowski, M. (2023, November 3). *Supply Chain Complexities: A Military Intelligence Approach*. Air University (AU). https://www.airuniversity.af.edu/Aether-ASOR/Perspectives/Article-Display/rticle/3579465/#:~:text=Using%20multiple%20sources%20of%20information%20and%20analytical%20methods%20will%20help

[3] Brown Jr., C. Q. (2020). *Accelerate Change or Lose* (pp. 1–8). Department of the United States Air Force. https://apps.dtic.mil/sti/pdfs/AD1109857.pdf

[4] Cochran, S., Abler, A. M., Keller, K. M., Lytell, M. C., Stallsworth, R. L., Thulin, R. C., Toukan, M., Walsh, M., & Winston, I. (2023). *The Forces We Need: Building Multi-Capable Airmen to Enable Agile Combat Employment*. RAND Corporation. https://www.rand.org/pubs/research_reports/RRA1746-1.html

[5] Cohen, R., & Losey, S. (2022, February 14). *US Air Force fleet's mission-capable rates are stagnating. Here's the plan to change that.* Air Force Times; Air Force Times. https://www.airforcetimes.com/news/your-air-force/2022/02/14/us-air-force-fleets-mission-capable-rates-are-stagnating-heres-the-plan-to-change-that/#:~:text=Ninety%20percent%20of%20the%20remotely%20piloted%20Reaper%20attack%20drones%20were

[6] Douglas, M., Roberts, M., & Ford, J. (2024). *People First, Mission Always: A Tension-Centered Approach to Conducting Safe, Effective Logistics.* Journal of Business Logistics, 45(4). https://doi.org/10.1111/jbl.12393

[7] Duvall, J. (2022, March 17). *Tesseract spotlights major wins, encourages participation in accelerating change - Logistics*

Officer Association. Logistics Officer Association. https://atloa.org/tesseract-spotlights-major-wins-encourages-participation-in-accelerating-change/#:~:text=The%20Tesseract%20team%20has%20become%20the%20epicenter%20of

[8] Hardin, D. (2023, May 6). *Rapid Sustainment Office's CBM+ artificial intelligence toolkit earns Air Force System of*. Air Force. https://www.af.mil/News/Article-Display/Article/3382513/

[9] Husseini, T. (2019, May 2). *F-35 progress: three challenges to the F-35 supply chain*. Airforce Technology. https://www.airforce-technology.com/features/f-35-progress-supply-chain/?cf-view

[10] Keating, E. G. (2018). *The depot-level maintenance of DoD's combat aircraft: insights for the F-35*. Congress of the United States, Congressional Budget Office. https://wayback.archive-it.org/6820/20210212081727/https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/53543-depotmaintenancef35.pdf

[11] Keating, E. G. (2019). *Approaches to F-35 Depot-Level Maintenance: Insights from Other Systems.* Defense Acquisition Research Journal: 26(1), 2–17. https://doi.org/10.22594/dau.18-804.26.01

[12] Korkmaz, G. (2024). *Supply Chain Risks and Management Strategies in the Defense Industry.* Journal of Defense Resources Management. 15(1). https://doaj.org/article/d85ce77746014c23853a88844c5f487c

[13] Leone, D. (2021, November 23). *Mission capable rates dropped in 2021 for every USAF fighter type except the A-10 - The Aviation Geek Club*. The Aviation Geek Club. https://theaviationgeekclub.com/mission-capable-rates-dropped-in-2021-for-every-usaf-fighter-type-except-the-a-10/

[14] Linden, J. R. (2004). *Bigger, better, faster, more: Jet fighter development and grand strategy in the United States Air Force, 1947–1953* (Order No. 1417608). Available from ProQuest One Academic. (305176598). https://www.proquest.com/dissertations-theses/bigger-better-faster-more-jet-fighter-development/docview/305176598/se-2

[15] Losey, S. (2019, August 1). *Aircraft mission-capable rates hit new low in Air Force, despite efforts to improve*. Air Force Times. https://www.airforcetimes.com/news/your-air-force/2019/07/26/aircraft-mission-capable-rates-hit-new-low-in-air-force-despite-efforts-to-improve/

[16] Losey, S. (2021, November 23). *"No company is immune": Supply chain woes weigh on defense firms*. Defense News. https://www.defensenews.com/air/2021/11/23/no-company-is-immune-supply-chain-woes-weigh-on-defense-firms/#:~:text=From%20massive%20deliveries%20of%20steel%20and%20aluminum%20needed%20to%20build

[17] Losey, S. (2024, April 23). *As the*

US Air Force fleet keeps shrinking, can it still win wars? Defense News. https://www.defensenews.com/air/2024/04/23/as-the-us-air-force-fleet-keeps-shrinking-can-it-still-win-wars/#:~:text=The%20Air%20Force%20in%20fiscal

[18] Mattis, J. (2018). *Summary of the 2018 National Defense Strategy of the United States of America*. Department of Defense. https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

[19] Mills, P., Nowak, S., Buryk, P., Drew, J. G., Guo, C., & Vardavas, R. (2018). *Increasing cost-effective readiness for the U.S. Air Force by reducing supply chain variance: technical analysis of flying hour program variance*. RAND Corporation. https://www.rand.org/pubs/research_reports/RR2118.html.

[20] Mirnenko, V., Pustovyi, S., Radko, O., & Yablonskyi, P. (2020). *Mathematical Model of Military Equipment Products Maintenance for the Condition-Based Operation Strategy Taking Into Account Type I Errors.* Journal of KONBiN, 50(1), 269–281. https://doi.org/10.2478/jok-2020-0016

[21] Pecho, P., Višnai, K., Trško, L., & Dianovský, R. (2023). *The Effect of Long-Term Aircraft Parking on Propulsion Units During the Covid-19 Pandemic*. Transportation Research Procedia (Online), 75, 229–239. https://doi.org/10.1016/j.trpro.2023.12.026

[22] Redfern, L. R. (2021, February 12). *Materiel Management Flight: Supplying the Mission*. Defense Logistics Agency; Department of Defense. https://www.dla.mil/About-DLA/News/News-Article-View/Article/2502352/#:~:text=The%2035th%20LRS%20Materiel%20Management%20Flight

[23] Shklarsky, I., & Shamir, E. (2023). *Driving innovation in air power: the cold war's four generations of fighter jets.* Defense & Security Analysis, 39(2), 146–170. https://doi.org/10.1080/14751798.2023.2178071

[24] Tadjdeh, Y. (2020). *Defense Industrial Base Rebounding From COVID-19.* National Defense, 105(800), 20–21. https://www.jstor.org/stable/27023051

[25] Tsarouhas, P., & Makrygianni, M. (2017). *A framework for maintenance and combat readiness management of a jet fighter aircraft.* International Journal of System Assurance Engineering and Management, 8(Suppl 2), 1895–1909. https://doi.org/10.1007/s13198-016-0481-8

[26] U.S. Chamber Staff. (2023, June 2). *U.S. Chamber Commends Passage of the Fiscal Responsibility Act to Avoid U.S. Default*. U.S. Chamber of Commerce. https://www.uschamber.com/economy/u-s-chamber-commends-passage-of-the-fiscal-responsibility-act-to-avoid-u-s-default

[27] U.S. Government Accountability Office (GAO). (2020). *Weapon System Sustainment: Aircraft*

Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely. https://www.gao.gov/assets/gao-21-101sp.pdf

[28] U.S. Government Accountability Office (GAO). (2021). *Depot Maintenance: DOD Should Improve Pandemic Plans and Publish Working Capital Fund Policy*. Gao.gov. Https://www.gao.gov/products/gao-21-103

[29] U.S. Government Accountability Office (GAO). (2022). *Weapon System Sustainment Aircraft Mission Capable Goals Were Generally Not Met and Sustainment Costs Varied by Aircraft Report to Congressional Committees*. https://www.gao.gov/assets/gao-23-106217.pdf

[30] U.S. Government Accountability Office (GAO). (2023). *Tactical Aircraft: Technical, Delivery, and Affordability Challenges Complicate DOD's Ability to Upgrade Its Aging Fleet*. Gao.gov. https://www.gao.gov/products/gao-23-106694

[31] Venable, J. (2021, Mar 22). *Why the F-35 Rules: Study History, Study Costs, Study Threats.* CE Think Tank; Newswire https://www.proquest.com/wire-feeds/why-f-35-rules-study-history-costs-threats/docview/2504276268/se-2