Global Defense Procurement and the F-35 Joint Strike Fighter

BERT CHAPMAN

Global Defense Procurement and the F-35 Joint Strike Fighter

Bert Chapman

Global Defense Procurement and the F-35 Joint Strike Fighter

palgrave
macmillan

Bert Chapman
Purdue University
West Lafayette, IN, USA

ISBN 978-3-030-01366-0 ISBN 978-3-030-01367-7 (eBook)
https://doi.org/10.1007/978-3-030-01367-7

Library of Congress Control Number: 2018962977

This Palgrave Macmillan imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

In Memoriam: Albert T. Chapman, Jr. (1920–2010)
Mildred S. Chapman (1926–2017).

Acknowledgments

Writing a book of this detail has been a time-consuming endeavor. Working at Purdue University Libraries, I am truly grateful to have supportive and collegial colleagues who understand the complexities and frustrations involved in writing a scholarly book. It is a blessing to work at a research library with a strong and enduring commitment to providing scholars from all disciplines with access to so many research and data resources.

I want to give particular thanks to my supervisor Professor Erla Heyns and Professor J.P. Herubel who have encouraged me to keep "plugging away" at this endeavor and reassuring me it would eventually be accomplished. Additional gratitude goes to Purdue History Professor Michael Smith, who was a constant source of support and encouraged me to try Palgrave Macmillan as a publisher.

Anca Pusca, Katelyn Zingg, Hemalatha Arumugam, Vinoth Kuppan, Dana De siena, and Leoselvakumar Periyanayagam have been consummate professionals in guiding me through Palgrave's publishing policies and procedures and making constructive suggestions for enhancing manuscript quality. This work has also been enhanced by the suggestions of its peer reviewers. I appreciate the permissions granted by the American Enterprise Institute, Center for Strategic and International Studies, and Lockheed Martin to use maps and photographs in this work. Sarah Reifel of Purdue's Roland Parrish Library provided very helpful graphic design input. Colin Anderson deserves credit for the powerful cover image.

I am also grateful for the encouragement of family and friends. My brother Brent and brother-in-law Mark Gick are always interested in my scholarly investigations, with Mark being particularly enthusiastic about aviation matters. The love and understanding of my wife Becky is an eternal source of blessing and joy. She has traveled with me to sites such as the Royal Air Force Museum and National Museum of the US Air Force to share my infatuation with the JSF and endured my seemingly incessant talk about this aircraft and its impact.

I'm sorry my parents did not live long enough to see this project reach completion. Albert T. Chapman was a Marion, IN, high school chemistry teacher whose interests went far beyond science and who positively impacted family, students, colleagues, fellow church members, and a wide network of individuals. My mother Dr. Mildred S. Chapman died on September 20, 2017. She heard me talk about this project often and I wish she could have lived long enough to see its culmination. She served as a Taylor University Education and English Professor, and was acutely interested in my writing, and helped endow me with a commitment to detail and presenting the highest-quality professional work and personal conduct. This work is dedicated to both of my parents and honoring their enduring legacy.

Contents

List of Figures

List of Tables

CHAPTER 1

Introduction

The US Department of Defense (DOD) is responsible for a global array of security responsibilities at a time of acute national budgetary constraints, war-weary public opinion, and emerging national security challenges from sources as diverse as China, Iran, North Korea, and Russia. During Fiscal Year (FY) 2018, (October 1, 2017–September 30, 2018), DOD's budget is projected to be $692.1 billion with $5.973 billion for the multiple variants of the Lightning II F-35 Joint Strike Fighter (JSF). The JSF's importance in future DOD military aviation planning was reflected in a February 24, 2014, proposed congressional budget submission advocating eliminating the A-10 fleet and replacing it with the JSF by the early 2020s.[1]

Militaries purchasing weapons systems must plan for the obsolescence of existing weapons, their eventual replacement, and the need to develop weapons systems capable of countering and defeating comparable weapons systems of current and potential adversaries in order to maintain competitive military advantages over these adversaries.[2] This has been particularly true for jet fighter planes. Around approximately 1993, the United States and allied militaries began looking at replacing the F-18 and F-111 jet fighter programs. The vehicle they came up with was the F-35 JSF and system development began in October 2001. Joint is defined by the US military as activities, operations, and organizations in which two or more military departments participate. JSF is a multinational acquisition aspiring to develop and field next-generation fighter aircraft for the Air Force,

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_1

Marine Corps, Navy, and eight international partners. It is a single-seat, single-engine aircraft incorporating low-observable stealth technologies, defense avionics, advance sensor fusion, internal and external weapons, and advanced prognostic maintenance capabilities.[3]

JSF's primary US contractors are Lockheed Martin for the aircraft and Pratt & Whitney for the engine. It is intended to be produced in three variants: replace the Air Force's F-16 Falcon, A-10 Thunderbolt; and complement the F-22A Raptor. JSF will also replace the Marine Corps F-18 Hornet and AV-8 Harrier aircraft, while providing the Navy with a multirole strike stealth aircraft to supplement the F-18 Super Hornet.[4]

During its existence the aircraft has experienced repeated delays and cost overruns. Targeted overall program costs began at $233 billion in October 2001, increased to $278.5 billion by March 2007, $395.7 billion in March 2012, nearly $400 billion in April 2015, falling to $379 billion through December 2015, and increasing to $406.48 billion by July 2017 according to US Government Accountability Office (GAO) and DOD reports. Annual funding costs are projected to average $12 billion annually through 2037 according to GAO and this same organization projects long-term JSF operational and support costs to surpass $1 trillion. These cost overruns and other factors have repeatedly pushed back the deployment of this aircraft and further delays are likely given the budget constraints facing the United States and its allies for the foreseeable future, although these budgetary restrictions may be lessened if the Trump Administration's proposed defense spending increases of $54 billion materialize.[5]

In addition, these countries' military forces are also undergoing intense debate on structuring themselves and their operational capabilities in view of the Asia-Pacific region's increasing strategic importance as demonstrated by China's growing military power and North Korean rhetorical belligerence in light of its nascent nuclear and ballistic missile arsenals. These countries are also having to contend with resurgent Russian military power in areas such as the Arctic, Mideast, and Ukraine; the continuing threat of the Islamic State (Daesh); and the potential dangers of Iranian military power despite the nuclear agreement reached between Tehran and the P 5+1 countries including the United States although the United States withdrew from this pact on May 8, 2018. The United States and its allies are also debating the future viability of traditional combat aircraft programs due to the emergence of drone aircraft, precision-guided munitions, cyberwarfare, and human-machine interaction in using military technology for combat operations.[6]

The work strives to provide a history of the JSF from a comparative multinational perspective transcending a US-centric approach to the JSF. It will emphasize governmental procurement practices, defense industry lobbying, legislative oversight, and governmental and military attitudes and experiences from selected participating countries. It makes heavy use of primary source government and military documents and some social media activity from multiple countries to illustrate the complexities of military acquisition and procurement and multinational consortial defense purchasing. The widespread public availability of materials on national military weapons systems purchases is also a theme of this analysis. It also stresses the role of legislators and parliamentarians, the perspectives of defense industry contractors and military personnel, and the objectives of national militaries and defense ministries. Understanding these variegated perspectives is critical in determining whether the JSF is necessary for becoming the primary military fighter plane against current and potentially emerging national security threats facing the United States and its allies from countries such as China and Russia and whether drone aircraft would be more effective against such threats.[7]

This work examines the history of this program in the United States and in selected allied countries including Australia, Canada, and the United Kingdom. It makes heavy uses of government and military documents including materials produced by congressional and parliamentary oversight committees and auditing agencies such as GAO, Australian National Audit Office, Britain's National Audit Office, and Canada's Auditor General. It will address the interdisciplinary intersection of areas such as defense acquisition, defense contracting, and national security policymaking, and strategic planning in a variety of countries seeking to find ways of addressing emerging military security challenges using emerging aerospace technologies and the high economic costs of attempting to meet these challenges.

Global Defense Procurement and the F-35 Joint Strike Fighter opens by providing a history of jet fighters from their emergence during World War II until the present. Particular emphasis is placed on how jet fighters are classified by numerical generations encompassing first to fifth generations with detailed descriptions of the technical capabilities of fighters representing these generations from the United States and allied countries and competitor nations including China and the Russian Federation/Soviet Union. This introductory chapter also discusses how the increasing financial costs and technological sophistication of jet fighter technology are limiting the number of countries and individual aerospace companies who can affordably produce these aircraft to meet their military customers' warfighting requirements.

The next chapter examines military aviation trends facing the United States and its allies including the threats posed by adversarial countries such as China, Iran, North Korea, and Russia. It addresses the role of Unmanned Aerial Vehicles in military operations; Chinese and Russian efforts and capabilities to limit the retaliatory capacity of US and allied militaries; discusses potential military operational scenarios and targets in which the United States and its allies may use the JSF to conduct military operations; and documents how the US aging jet fighter fleet is weakening its military capacity against these emerging threats and prompting the need for new multi-mission military aircraft such as the JSF.

Additional chapters describe the historical development and evolution, controversy, success, and failures experienced by the JSF in the United States and other countries. Since this is a global program with international economic, military, and political implications, particular emphasis is placed on how countries besides the United States have addressed the JSF in their governmental policymaking. While not all countries allied with the United States have adopted the JSF as a warfighting tool, it has been considered or adopted by many including Australia, Canada, Denmark, Israel, Italy, Japan, the Netherlands, Norway, South Korea, Singapore, Taiwan, and Turkey. In addition to detailed coverage of discussions of whether the military capability of the JSF is affordable and essential for individual countries' national security requirements, this treatise also emphasizes the widespread economic impact of the JSF in these countries by listing where contractor or subcontractor facilities are located in these countries and how this incentivizes the desire of the aerospace industry in these countries and their elected representatives to participate in this program. The role of political contributions in the United States by aerospace industry companies and labor unions is also stressed including listing selected political contributions made to congressional representatives by these organizations during the 2015–2016 congressional election cycle.

The conclusion emphasizes the close relationship between military spending and the aerospace industry; stresses the need for JSF critics to present economically and militarily credible alternatives to emerging US and allied jet fighter fleets beyond maintaining existing combat aircraft; and stresses the vital importance of the United States and its allies maintaining operational military superiority against adversaries like China and Russia who are determined to utilize emerging aerospace technological advances to promote their geopolitically revisionist international security aspirations. This chapter also analyzes critical weaknesses in the belief that machine-operated aircraft can meet emerging military requirements; documents the positive reaction pilots from the United States and other countries have concerning the JSF's capabilities and flight performance; acknowledges JSF program managerial performance and financial problems which have occurred with many other weapons systems; references Israel's successful use of the JSF in May 2018 operations against Iranian and Hezbollah targets in Lebanon; and stresses the United States' need to strengthen domestic scientific and technological agility to address emerging national security threats due to the global proliferation of scientific and technological expertise. This can be partially accomplished by building and maintaining the JSF to address emerging Chinese and Russian threats and technological advances and threats posed by other national and transnational entities to the United States and allied strategic interests.

Notes

1. See *National Defense Authorization Act for Fiscal Year 2018: Conference Report to Accompany H.R. 2810*, (House Report 115-404); (Washington, DC: GPO, 2017): 698, 707, 710, 761; https://www.congress.gov/115/crpt/hrpt404/CRPT-115hrpt404.pdf; Accessed December 18, 2017; and Nick Simeone, "Hagel Outlines Budget Reducing Troop Strength, Force Structure," (Washington, DC: Armed Forces Press Service, February 24, 2014): 1; http://archive.defense.gov/news/newsarticle.aspx?id=121703; Accessed December 18, 2017.
2. See *The Dynamics of Military Revolution 1300–2050*, MacGregor Knox and Williamson Murray, eds., (New York: Cambridge University Press, 2001); *The Sources of Military Change: Culture, Politics, and Technology,* Theo Farrell and Terry Terriff, eds., (Boulder, CO: Lynne Rienner Publishers 2002); Williamson Murray, *Military Adaptation in War With Fear of Change*, (New York: Cambridge University Press, 2011); Burak Kadercan, "Strong Armies, Slow Adaptation: Civil-Military Relations and the Diffusion of Military Power," *International Security*, 38 (3)(Winter 2013/14): 117–152; https://doi.org/10.1162/ISEC_a_00146; and *International Military Operations in the 21st Century: Global Trends and the Future of Intervention*, Per M. Norheim-Martinsen and Tore Nyhamer, eds. (London: Routledge, 2015).
3. See U.S. Joint Chiefs of Staff, *DOD Dictionary of Military and Associated Terms*, (Washington, DC: U.S. Joint Chiefs of Staff, 2018): 123; http://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/dictionary.pdf; Accessed August 15, 2018; and Jeremiah Gertler, *F-35 Joint Strike Fighter (JSF) Program*, (Washington, DC: Library of Congress, Congressional Research Service, 2014); https://digital.library.unt.edu/ark:/67531/metadc944760/; Accessed March 24, 2017.

4. U.S. Government Accountability Office, *F-35 Joint Strike Fighter: Continued Oversight Needed as Program Plans to Begin Development of New Capabilities,* (Washington, DC: GAO, 2016): 5–6; http://www.gao.gov/assets/680/676762.pdf; Accessed March 24, 2017.
5. See GAO, 5–6; Gertler, and U.S. Department of Defense, *Department of Defense Selected Acquisition Reports (SARs)—December 2016*, (Washington, DC: DOD, July 18, 2017: 8; https://www.defense.gov/News/News-Releases/News-Release-View/Article/1251392/department-of-defense-selected-acquisition-reports-sars-december-2016/; Accessed December 18, 2017.
6. See Raphael S. Cohen and Gabriel M. Scheinmann, "Can Europe Fill the Void in U.S. Military Leadership?," *Orbis*, 58 (1)(Winter 2014): 39–54; https://doi.org/10.1016/j.orbis.2013.11.002; U.S. Government Accountability Office, *The F-35 Joint Strike Fighter: Current Outlook is Improved, But Long-Term Affordability is a Major Concern*, (Washington, DC: GAO, 2013): 3, 5, 1; www.gao.gov/assets/660/652948.pdf; Accessed March 24, 2017; Ibid., *F-35 Joint Strike Fighter: Assessment Needed to Address Affordability Challenges*, (Washington, DC: GAO, 2015): 1; http://www.gao.gov/assets/670/669619.pdf; Accessed March 24, 2017; Paul Cornish and Andrew M. Dorman, "Complex Security and Strategic Latency: The UK Strategic Defence and Security Review 2015," *International Affairs*, 91 (2) (2015): 351–370; https://www.chathamhouse.org/sites/files/chathamhouse/INTA91_2_09_Cornish_Dorman.pdf; Accessed May 25, 2018; U.S. Office of Management and Budget, *America First: A Budget Blueprint to Make America Great Again*, (Washington, DC: GPO, 2017): 15–16; https://www.gpo.gov/fdsys/pkg/BUDGET-2018-BLUEPRINT/pdf/BUDGET-2018-BLUEPRINT.pdf; Accessed March 24, 2017; and "Remarks by President Trump on the Joint Comprehensive Plan of Action," (Washington, DC: The White House, May 8, 2018): 1–7; https://www.whitehouse.gov/briefings-statements/remarks-president-trump-joint-comprehensive-plan-action/; Accessed August 15, 2018.
7. See Marc R. Devore, "Arms Production in the Global Village: Options for Adapting to Defense-Industrial Globalization," *Security Studies*, 22 (3) (2013): 532–572; https://doi.org/10.1080/09636412.2013.816118; Eleni Ekmektsioglu, "Hypersonic Weapons and Escalation Control in East Asia," *Strategic Studies Quarterly*, 9 (2)(Summer 2015): 62; http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-09_Issue-2/ekmektsioglou.pdf; Accessed March 24, 2017; John R. Deni, NATO's Rebirth: NATO's New Trajectories After the Wales Summit." *Parameters*, 44 (3)(Autumn 2014): 57–65; http://ssi.armywarcollege.edu/pubs/parameters/Issues/Autumn_2014/USAWC_Quarterly_Parameters_Autumn_v44n3.pdf; Accessed August 14, 2018; Luis Simón, "NATO's

Rebirth: Assessing NATO's Eastern European 'Flank'", *Parameters*, 44 (3) (Autumn 2014): 67–79; http://www.strategicstudiesinstitute.army.mil/pubs/parameters/Issues/Autumn_2014/USAWC_Quarterly_Parameters_Autumn_v44n3.pdf; Accessed March 20, 2017; U.S. Congress, House Committee on Armed Services, *Russian Military Developments and Strategic Implications*, (Washington, DC: GPO, 2015); http://purl.fdlp.gov/GPO/gpo54841; Accessed March 24, 2017; Vipin Narang, "Nuclear Strategies of Emerging Powers: North Korea and Iran," *Washington Quarterly*, 38 (1) (2015): 73–91; https://doi.org/10.1080/0163660X.2015.1038175; Dian Matteo, "The Pivot to Asia, Air-Sea Battle and Contested Commons in the Asia-Pacific Region," *The Pacific Review*, 28 (2)(2015): 237–257; https://doi.org/10.1080/09512748.2014.995124; *Human-Robot Interactions in Future Military Operations*, Michael Barnes and Florian Jentsch, eds., (London: Routledge, 2016); Jacquelyn Schneider and Julia Macdonald, "Technology and Adaptation on the Modern Battlefield", Social Science Research Network, 2016; https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2814202_code2104798.pdf?abstractid=2814202&mirid=1/; Accessed March 24, 2017; Michael W. Byrnes, "Nightfall: Machine Autonomy in Air-to-Air Combat," *Air and Space Power Journal*, 28 (3)(May/June 2014): 48–75; http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-3/F-Byrnes.pdf; Accessed August 15, 2018; John D. Jogerst, "The Fifth-Generation Fighter Pilot Force," *Air and Space Power Journal*, 30 (4)(Winter 2016): 92–94; http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2016-Winter/C-Jogerst.pdf; Accessed March 24, 2017; and Andrew Herr, "Will Humans Matter in the Wars of 2030?," *Joint Force Quarterly*, 77 (2nd Quarter 2015): 76–83; http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-77/jfq-77_76-83_Herr.pdf; Accessed March 24, 2017.

References

Byrnes, Michael W. "Nightfall: Machine Autonomy in Air-to-Air Combat." *Air and Space Power Journal*, 28 (3) (May/June 2014): 48–75. http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-3/F-Byrnes.pdf. Accessed August 15, 2018.

Cohen, Raphael S., and Gabriel M. Scheinmann. "Can Europe Fill the Void in U.S. Military Leadership?." *Orbis*, 58 (1) (Winter 2014): 39–54. https://doi.org/10.1016/j.orbis.2013.11.002.

Cornish, Paul, and Andrew M. Dorman. "Complex Security and Strategic Latency: The UK Strategic Defence and Security Review 2015." *International Affairs*, 91 (2) (2015): 351–370. https://www.chathamhouse.org/sites/files/chathamhouse/INTA91_2_09_Cornish_Dorman.pdf. Accessed May 25, 2018.

Deni, John R. "NATO's Rebirth: NATO's New Trajectories After the Wales Summit." *Parameters*, 44 (3) (Autumn 2014): 57–65. http://ssi.armywarcollege.edu/pubs/parameters/Issues/Autumn_2014/USAWC_Quarterly_Parameters_Autumn_v44n3.pdf. Accessed August 14, 2018.

Devore, Marc R. "Arms Production in the Global Village: Options for Adapting to Defense-Industrial Globalization." *Security Studies*, 22 (3) (2013): 532–572. https://doi.org/10.1080/09636412.2013.816118.

The Dynamics of Military Revolution 1300–2050. MacGregor Knox and Williamson Murray, eds. (New York: Cambridge University Press, 2001).

Ekmektsioglu, Eleni. "Hypersonic Weapons and Escalation Control in East Asia." *Strategic Studies Quarterly*, 9 (2) (Summer 2015): 62. http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-09_Issue-2/ekmektsioglou.pdf. Accessed March 24, 2017.

Gertler, Jeremiah. *F-35 Joint Strike Fighter (JSF) Program* (Washington, DC: Library of Congress, Congressional Research Service, 2014). https://digital.library.unt.edu/ark:/67531/metadc944760/. Accessed March 24, 2017.

Herr, Andrew. "Will Humans Matter in the Wars of 2030?" *Joint Force Quarterly*, 77 (2nd Quarter 2015): 76–83. http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-77/jfq-77_76-83_Herr.pdf. Accessed March 24, 2017.

Human-Robot Interactions in Future Military Operations. Michael Barnes and Florian Jentsch, eds. (London: Routledge, 2016).

International Military Operations in the 21st Century: Global Trends and the Future of Intervention. Per M. Norheim-Martinsen and Tore Nyhamer, eds. (London: Routledge, 2015).

Jogerst, John D. "The Fifth-Generation Fighter Pilot Force." *Air and Space Power Journal*, 30 (4) (Winter 2016): 92–94. http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2016-Winter/C-Jogerst.pdf. Accessed March 24, 2017.

Kadercan, Burak. "Strong Armies, Slow Adaptation: Civil-Military Relations and the Diffusion of Military Power." *International Security*, 38 (3) (Winter 2013/14): 117–152. https://doi.org/10.1162/ISEC_a_00146.

Matteo, Dian. "The Pivot to Asia, Air-Sea Battle and Contested Commons in the Asia-Pacific Region." *The Pacific Review*, 28 (2) (2015): 237–257. https://doi.org/10.1080/09512748.2014.995124.

Murray, Williamson. *Military Adaptation in War With Fear of Change* (New York: Cambridge University Press, 2011).

Narang, Vipin. "Nuclear Strategies of Emerging Powers: North Korea and Iran." *Washington Quarterly*, 38 (1) (2015): 73–91. https://doi.org/10.1080/0163660X.2015.1038175.

National Defense Authorization Act for Fiscal Year 2018: Conference Report to Accompany H.R. 2810 (House Report 115-404). (Washington, DC: GPO, 2017): 698, 707, 710, 761. https://www.congress.gov/115/crpt/hrpt404/CRPT-115hrpt404.pdf. Accessed December 18, 2017.

"Remarks by President Trump on the Joint Comprehensive Plan of Action." (Washington, DC: The White House, May 8, 2018): 1–7. https://www.whitehouse.gov/briefings-statements/remarks-president-trump-joint-comprehensive-plan-action/. Accessed August 15, 2018.

Schneider, Jacquelyn, and Julia Macdonald. "Technology and Adaptation on the Modern Battlefield." *Social Science Research Network*, 2016. https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2814202_code2104798.pdf?abstractid=2814202&mirid=1/. Accessed March 24, 2017.

Simeone, Nick. "Hagel Outlines Budget Reducing Troop Strength, Force Structure" (Washington, DC: Armed Forces Press Service, February 24, 2014): 1. http://archive.defense.gov/news/newsarticle.aspx?id=121703. Accessed December 18, 2017.

Simón, Luis. "NATO's Rebirth: Assessing NATO's Eastern European 'Flank'". *Parameters*, 44 (3) (Autumn 2014): 67–79. http://ssi.armywarcollege.edu/pubs/parameters/Issues/Autumn_2014/USAWC_Quarterly_Parameters_Autumn_v44n3.pdf. Accessed August 15, 2018.

The Sources of Military Change: Culture, Politics, and Technology. Theo Farrell and Terry Terriff, eds. (Boulder, CO: Lynne Rienner, 2002).

U.S. Congress. House Committee on Armed Services. *Russian Military Developments and Strategic Implications* (Washington, DC: GPO, 2015). http://purl.fdlp.gov/GPO/gpo54841. Accessed March 24, 2017.

U.S. Department of Defense. *Department of Defense Selected Acquisition Reports (SARs)—December 2016* (Washington, DC: DOD, July 18, 2017): 8. https://www.defense.gov/News/News-Releases/News-Release-View/Article/1251392/department-of-defense-selected-acquisition-reports-sars-december-2016/. Accessed December 18, 2017.

U.S. Government Accountability Office. *The F-35 Joint Strike Fighter: Current Outlook is Improved, But Long-Term Affordability is a Major Concern* (Washington, DC: GAO, 2013): 3, 5, 1. www.gao.gov/assets/660/652948.pdf. Accessed March 24, 2017.

———. *F-35 Joint Strike Fighter: Assessment Needed to Address Affordability Challenges*. (Washington, DC: GAO, 2015): 1. http://www.gao.gov/assets/670/669619.pdf. Accessed March 24, 2017.

———. *F-35 Joint Strike Fighter: Continued Oversight Needed as Program Plans to Begin Development of New Capabilities* (Washington, DC: GAO, 2016): 5–6. http://www.gao.gov/assets/680/676762.pdf. Accessed March 24, 2017.

U.S. Joint Chiefs of Staff. *DOD Dictionary of Military and Associated Terms* (Washington, DC: U.S. Joint Chiefs of Staff, 2018): 123. http://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/dictionary.pdf. Accessed August 15, 2018.

U.S. Office of Management and Budget. *America First: A Budget Blueprint to Make America Great Again* (Washington, DC: GPO, 2017): 15–16. https://www.gpo.gov/fdsys/pkg/BUDGET-2018-BLUEPRINT/pdf/BUDGET-2018-BLUEPRINT.pdf. Accessed March 24, 2017.

CHAPTER 2

History of Jet Fighters

Understanding the historical development and evolution of fighter planes must recognize that this is an evolutionary process encompassing the twentieth and twenty-first centuries. Descriptions of fighter planes, whether from the United States, allied countries, or enemy countries, often use the term "generation" to describe the developmental stage of these weapons.

Jet fighters emerged during the latter part of World War II. First-generation fighters refer primarily to turbojet engine-powered aircraft. Their primary weapons were machine guns, cannon, dumb bombs, and eventually air-to-air missiles. Some first-generation aircraft were supersonic (capable of cruising beyond the speed of sound [1236 kilometers/768 miles per hour]) and some used radar to operate at night in an interceptor role. Examples of such aircraft include the US F-86 Sabre used effectively during the Korean War against the Soviet Union's MiG-15 and MiG-17. Most first-generation fighters, however, could not sustain supersonic flight levels and did not have good endurance.[1]

Second-generation fighters were prevalent from the mid-1950s-early 1960s. These aircraft maintained supersonic speed in level fight and the air-to-air missile became their primary weapon replacing the cannon and machine gun. Technological innovation enabled these aircraft to carry onboard radar facilitating tracking down enemies beyond visual range. Dogfighting was deemphasized in favor of bigger missile payloads and

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_2

better radar. Examples of such fighters include the F-104 and F-105 from the United States and its allies and the MiG-19 and MiG-21 from the Soviet Union and its allies.[2]

Third-generation fighters from the early 1960s to 1970 featured production of multi-mission role jet aircraft capable of conducting both ground attack and air defense. Emerging technologies including vertical/short take-off and landing (V/STOL) and thrust vectoring (an aircraft's ability to direct thrust from its main engines in a direction besides parallel to the aircraft's longitudinal axis) were incorporated into aircraft enabling them to use shorter runways and perform better maneuver. Enhanced ground attack capability was supported by air-to-surface missile (ASM) and laser-guided bomb (LGB). Examples include US and allied aircraft such as the F-4 and Mirage III and Soviet bloc aircraft such as the MiG-23.[3]

Fourth-generation fighters held sway from 1970 to the late 1980s. These were designed for network-centric battlefields and performing multi-mission tasks. Emphasizing maneuverability instead of speed was critical and such aircraft were equipped with multimode avionics capable of changing from air-to-ground modes, making it easier to perform ground attack and air superiority tasks. Radar-absorbing stealth coating technology began to be introduced on planes such as the F-16 Fighting Falcon and F-117 Nighthawk. Other aircraft falling in this generation include US and allied F-15, F-16, F-18/A, Mirage 2000, and Soviet bloc MiG-29 and Su-27.[4]

Four and a half generation fighters emerged during the late 1980s and early 1990s. These had more advanced technology than fourth-generation fighters but were not advanced enough to reach the fifth-generation threshold. Some of these fighters were made of lighter composite material with stealth coating, possessing high-altitude supercruise capability, and armed with digital avionics and sophisticated weapons include beyond visual range air-to-air-missiles (AAM), Global Positioning System (GPS)-guided missiles, and helmet-mounted displays. Examples of these aircraft include the Eurofighter Typhoon, Dassault Rafale, Saab JAS 39 Gripen, and F/A-18E/F Super Hornet.[5]

Fifth-generation fighters date from 2005 to present and describe aircraft fitted with advanced very low observable (VLO) stealth, integrated information and sensor fusion, along with air-to-air and air-to-ground capabilities producing enhanced fighting agility, reliability, maintainability, and deployability. Fifth-generation fighters equip pilots with 360° situational awareness and network-centric capability. US examples of these aircraft include the F-22 Raptor and F-35 JSF with the Russian MiG MFI and Su-47 and the Chinese Chengdu J-20.[6]

The United States, its allies, and enemies have produced significant numbers of jet fighters during the jet age and have seen these fighters achieve both success and failure, increasing technological sophistication, and increasing financial costs. These fighters have been produced to fulfill national missions and interests in implementing four airpower strategic options: influencing and shaping, deterrence, coercion, and punishment.[7] A 1998 Rand Corporation study on the historical evolution of jet fighters describes three broad periods of fighter development after World War II (see Table 2.1).

Table 2.1 Historical jet fighter development[8]

Timeframe	*Overall technology and procurement requirements*	*Dominant performance goals*	*Technology drivers*
1940s–1950s (1st and 2nd generations)	Technology revolution. Many R&D programs Much prototyping many capable contractors requirement consensus	Speed Ceiling Rate of climb	Aerodynamics propulsion materials
1960s–1970s (3rd and 4th generations) Technology refinement Fewer R&D programs Less prototyping R&D policy revolution Fewer contractors Requirements debate Maneuverability Agility Flexibility Multirole	Technology refinement Fewer R&D programs Less prototyping R&D policy revolution Fewer contractors Requirements debate	Maneuverability Agility Flexibility Multirole	Avionics System integration Propulsion
1970s–1990s (5th generation)	Technology revolution Fewer R&D programs Increased prototyping Fewer experienced contractors Requirements consensus	Stealth	Airframe shaping materials Avionics

US Jet Fighters 1940s–1950s

The US military began developing jet technology during World War II, but remained behind German technology in aeronautical and jet propulsion research during this era as demonstrated by Berlin's ME-262 which saw some action during this conflict and achieved partial success against allied aircraft.[9] Early US military jet fighter procurement involved the Army Air Force and the Navy before the Air Force became an independent military services as a result of the 1947 National Security Act.[10]

Rapid technological advances in the 1950s including speed increases and altitude capabilities by fighters and bombers facilitated supersonic fighter development and Eisenhower Administration mission performance goals emphasizing the preeminence of nuclear weapons in US military strategy. Eisenhower's "massive retaliation" policy stressed strategic and tactical nuclear missions for the military and caused the Air Force, and to a lesser extent the Navy, to seek fighters and bombers capable of operating in strategic and tactical nuclear environments. During this time period, major advances in jet turbine engine power and efficiency, the afterburner's emergence, and resolving basic aerodynamic design problems stemming from very-high-speed flight produced exponential increases in aircraft speed and altitude capabilities from both the military and private sector contractors.[11]

Examples of US jet fighters deployed between 1946 and 1958 are shown in Table 2.2.

Table 2.2 US jet fighters deployed between 1946 and 1958[12]

Fighter ceiling (ft.)	*First flight*	*Cost based on 100 aircraft production run—2016 CPI dollars*	*Empty weight (lbs)*	*Max. speed (mph)*	*Ceiling (ft.)*
F-84G	1946	2,220,000	11,095	622	40,500
F-86F	1947	1,960,000	10,950	678	45,000
F-86D	1949	3,200,000	13,948	692	49,600
F-89D	1948	8,140,000	21,000	610	48,000
F-94C	1949	4,990,000	12,708	600	51,400
F-100D	1953	6,970,000	21,000	864	47,700
F-101B	1954	15,400,000	28,000	1100	50,300
F-102A	1953	11,200,000	19,460	825	51,800
F-104C	1954	16,300,000	14,082	1450	58,000
F-105D	1955	17,400,000	27,500	1480	50,000
F-106A	1956	39,700,000	23,646	1525	52,000
F-4C	1958	14,600,000	28,540	1500	55,400

These aircraft were developed, produced, and researched by the armed services branches, the National Advisory Committee on Aeronautics (NACA), and companies as diverse as Bell, Boeing, Convair, Douglas, Grumman, Lockheed, McDonnell, North American, Northrop, Republic, and Vaught.[13]

1960s–1970s

These decades saw the US military become involved in the Vietnam War in which fighter aircraft played a significant part, a shift in US nuclear doctrine from massive retaliation to flexible response, and the rise of the Soviet Union as rival to US air power supremacy. Key technological developments and capabilities occurring during this era included fly-by-wire (FBW) flight control systems, negative static stability, operational variable geometry fighters, the genesis of stealth, and sustained Mach 3+ flight. This period also experienced considerable intellectual debate, disagreement, and ferment concerning fighter performance and design goals, mission roles, doctrine, and operational concepts. Results of this debate included shifting emphasis from heavy, fast, multirole fighter-attack aircraft to lighter, more agile, specialized air combat fighters. Escalating costs lead to increasing attempts to reform the weapons acquisition process driven by the speed, technological complexity, and weight of military aircraft, producing drastic escalation in research and development and procurement costs.[14]

Examples of fighter planes purchased by the United States during this time period are shown in Table 2.3.

Table 2.3 US jet fighters purchased during the 1960s and 1970s[15]

Fighter	*First flight*	*Cost based on 100 aircraft production run—2016 CPI dollars*	*Empty weight (lbs)*	*Max speed (mph)*	*Ceiling (ft.)*
A-6	1960	63,500,000	25,630	648	40,600
LTV A-7 Corsair	1965	21,800,000	19,127	690	42,000
A-10	1972	19,000,000	24,959	439	45,000
EA-6B	1968	76,600,000	31,160	651	37,600
F-5 A/B	1962	7,730,000	9558	1060	51,800
F-14	1970	55,900,000	43,735	1544	50,000
F-15	1972	41,200,000	28,000	1650	65,000
F-16	1974	21,600,000	19,700	1500	50,000
F/A-18	1978	34,500,000	23,000	1190	50,000
SR-71 (started as YF-120)	1963	55,200,000–66,200,000	60,730	2275	90,000

1980s–1990s

These decades saw the United States rebuild its military power to achieve Cold War victory over the Soviet Union and its allies, the successful performance of US military airpower during Operation Desert Storm against Iraq in 1991, and declining defense spending during the 1990s in the Cold War's aftermath. At the same time US airpower military was used in operations in the Balkans during the 1990s and in enforcing no-fly zones against Saddam Hussein's Baathist regime in Iraq. This time period saw increasing technological sophistication in US military aircraft marked by the emergence of precision-guided munitions, and the increasing use of and reliance on space-based technology such as GPS and stealth technology.[16]

The significance of this latter technology is described in a 1998 Rand Corporation report:

> Stealth technology aims at reducing as much as possible the radar, IR, acoustic, and visual signatures of combat aircraft to avoid enemy detection, to enhance survivability and achieve surprise. The highest priority and most challenging aspect of stealth is achieving a low radar cross section (RCS). This is because radars can detect conventional aircraft at up to several hundred miles range, providing ample warning time for defenders, while IR, acoustic, and visual sensors have much shorter detection ranges in most situations. Stealth became increasingly of interest to Air Force and DoD planners in the 1970s. The continuing development of a variety of technologies increased stealth's cost effectiveness as a means of countering rapidly improving Soviet air-defense capabilities. In the case of the strategic bomber, stealth appeared to be the only way to ensure the survivability, and thus the continued existence, of penetrating manned bombers into the 1990s.[17]

Examples of fighter planes purchased by the United States during this era are shown in Table 2.4.

A significant factor influencing the increasing costs of military aviation programs such as the JSF has been aerospace industry consolidation occurring in the 1990s. During 1993 Lockheed purchased General Dynamics Fort Worth fighter division ending nearly a half century of independent combat aircraft research and development leadership dating back to the B-24 Liberator and Convair delta jets from the 1940s to the 1950s. In mid-1994, Lockheed and Martin-Marietta merged becoming Lockheed Martin. In April 1994, Northrup purchased Grumman which served as the Navy's premier fighter developer since the 1930s and this

Table 2.4 US jet fighters purchased in the 1980s and 1990s[18]

Fighter	*First flight*	*Cost based on 100 aircraft production run—2016 CPI dollars*	*Empty weight (lbs)*	*Max speed (mph)*	*Ceiling (ft.)*
A-6F Intruder	1987	63,400,000	25,630	648	40,600
F-14A	1986	55,900,000	43,735	1544	50,000+
F-15E	1986	45,800,000	31,700	1650	60,000
F-16XL	1982	27,700,000	22,000	600	50,000
F/A 18-C/D	1984	42,600,000	23,000	1190	50,000
F-20	1982–canceled 1986	1,770,000,000 program cost	55,000	1522	55,000
F-22	1997	168,000,000	43,340	1500	>65,000
F-117A	1996	62,000,000	29,500	617	45,000

time period also saw Northrup complete its purchase of LTV. In 1996 Boeing bought Rockwell's aerospace and defense divisions who were developers of the first operational supersonic fighter. Soon after Boeing merged with McDonnell-Douglas and in July 1997 Lockheed Martin acquired Northrop Grumman. The net result of these mergers saw fighter R&D leaders such as General Dynamics, Grumman, McDonnell-Douglas, Northrop, and Rockwell eliminated as independent entities, leaving the number of credible combat air fighter contractors as Boeing and Lockheed Martin.[19]

2000s–Present

The twenty-first century has seen the US defense aerospace industry continue production, maintenance, and updating of existing fighter systems such as those covered in the previous chart and the JSF. Increasing concerns for the US military's jet fighter fleet is the fleet's aging, declining production, and accelerating costs in an environment of lowered defense spending characterizing political discussion and analysis of recent US military jet fighter development. A 2015 *Defense Industry Daily* report maintained that the average age of the current Air Force fleet is 26 years with some transport and aerial refueling tankers being 40–50 years old and facing the possibility of reaching 70–80 years before they are retired.[20]

A 2010 Heritage Foundation analysis determined the average age of the following military aircraft platforms to be:

- Air Force tactical aircraft—over 20 years;
- Navy and Marine Corps tactical aircraft—over 15 years;
- CH-47 Chinook helicopters—nearly 20 years;
- UH-1 Huey helicopters—35 years;
- P-3C Orion long-range aircraft—almost 25 years;
- B-1 Lancer bomber—over 20 years;
- C-5A Galaxy transport aircraft—40 years; and
- KC-135 tankers—44 years.[21]

A follow-up 2015 assessment by the same organization noted the decline in naval strike aircraft to a single model, the F/A-18; rated its air wing capacity 3 on a scale of 5 based on the ability to meet a two major regional contingencies requirement with a 20% reserve; and gave it an overall score of "marginal" in its ability to meet readiness requirements. The Air Force was appraised as being on track to the smallest size in its history; noted that budget constraints were reducing it to 26 Tactical Air Squadrons encompassing air superiority fighters, strike fighters, and attack planes; average aircraft age is 28 years; that the F-15 constitutes 71% of its air superiority platforms but has reached 90% of its estimated 30-year service life and the F-16 has consumed 80% of its expected life span; and that combat flying hours were down 18% in FY 2013. The Air Force received strong ratings in capacity and readiness but a marginal rating in capability.[22]

Other countries allied with the United States and opposed to the United States have also developed and purchase jet fighter aircraft to accommodate their national security needs. Their experiences will now be profiled.

Australian, British, and Canadian Jet Fighters

Australian, British, and Canadian air forces have purchased jet fighter planes to meet their own national security needs and to successfully interoperate with either the US military or other North Atlantic Treaty Organization (NATO) forces. These countries have generally purchased US fighters while, at the same time and with varying degrees of success and failure, developed their own indigenous defense aerospace industrial capabilities, or purchased jet fighters from other countries. Considerable literature exists documenting the experiences of these programs and assessing future manned jet fighter purchases by these countries.[23]

Australian jet fighter purchases have primarily been made by the Royal Australian Air Force (RAAF), whose current name dates from March 31, 1921. RAAF currently employs 14,388 personnel supported by 4028 reserve and 800 civilian personnel at 17 major bases and various offices across Australia.[24] These planes have been purchased to facilitate RAAF cooperation and interoperability with the United States, New Zealand, and other countries allied with Canberra. During the jet age, RAAF fighters have seen action in theaters of operation as varied as the Korean War, Vietnam War, various international peacekeeping operations, and military operations in Afghanistan and Iraq. Australia is also developing its military airpower capability to monitor China's increasing military assertiveness which may eventually adversely affect Canberra's international economic and strategic interests in the Asia-Pacific region.[25]

Jet fighters purchased by the RAAF during the jet age are shown in Table 2.5.

Table 2.5 RAAF jet fighters purchased during the jet age[26]

Fighter	*Maximum speed (mph)*	*Weapons*
EA-18G Growler	1190	AIM 9 Sidewinder; AGM 88 Harm missiles; AIM 120 AMRAAM missiles
F-4 E Phantom	1485	General Electric M61 20 mm six-barrel cannon; up to 16,000 lbs stores including bombs, missiles, rockets
F/A-18 A/B Hornet	1190	Two AIM 7 Sparrow, two AIM-9M Sidewinder AAMs, 20 mm M61 gun, variety of air-to-surface weaponry, such as Mk 82 bombs, 70 mm rockets, harpoon anti-ship missiles
F/A-18 F Super Hornet	1190	Four AIM 9 Sidewinder; four AIM 120 AMRAAM; JDAM precision-guided munitions
F-86 Sabre	692	Six .50 caliber machine guns
F-104	1328	20 mm Vulcan Gatling autocannon capable of firing 6000 rounds per minute
F-111	1650	20 mm Vulcan six-barreled Gatling cannon; LGBs 2000 and 4800 lbs
Mirage	1674 depending on altitude	One Matra R530 and either two Sidewinder AIM-9B or two Matra R550 Magic air-to-air missiles and twin 30 mm DEFA cannon. Ground attack weapons such as six Mk 82,227 kg (500 lbs) bombs or three GBU-12 LGBs
JSF	1199	AIM 120 AMRAAM; AIM 9X Sidewinder; joint air-to-ground missile; joint strike missile; JDAM precision-guided munitions.

British

The United Kingdom's Royal Air Force (RAF) was established on April 1, 1918, and it and the Royal Navy (RN) have engaged in operations globally during its existence. During the Cold War, it was an integral part of the NATO alliance seeking to deter the former Soviet Union; it maintains close ties with the Air Forces in former British colonies globally, and has participated with the United States in many military operations in areas such as Iraq and Libya. Although the RAF has experienced reduced funding as discussed in Chap. 4, it possesses a highly professionalized workforce of 30,560 regular forces and 6330 reserves as of October 1, 2017, and possesses a significant arsenal capable of effectively enforcing British national interests in many global regions against a diverse variety of enemies in multiple operational environments. Increasing Russian assertiveness in the North Atlantic and Western Europe has increased the need for the United Kingdom to have effective and lethal jet fighter forces.[27]

Examples of jet fighters purchased by the RAF and RN in recent decades are shown in Table 2.6.

Table 2.6 Historic and recent RAF jet fighter purchases[28]

Fighter	*Maximum speed (mph)*	*Ceiling*	*Weapons*
Avro Shackleton De Havilland Venom	640	39,400	4 × 0.20 mm Hispano MKv cannon; 8 60 lbs rockets; 2 1000 lbs
Blackburn Buccaneer S.2.	667	40,000	One internal rotating bomb bay 12,000 lbs capacity; 18 SNEB 68 mm rockets; 2 AIM 9 Sidewinders; LGBs
English Electric Lightning F-6	1300	54,000	2 × 30 mm Aden Cannon; two De Havilland Firestreak or two Hawker Siddeley red top missiles
F-5 Phantom	1060	51,800	2 × 20 mm M39A2 revolver cannons; Hydra 79 mm rockets; 4 AIM 9 Sidewinders or 4 AIM AMRAAMs; Paveway bombs;
F-86 Sabre	692	49,600	Six .50 caliber machine guns
Harrier GR7	660	43,000	CRV-7; AIM-9 L Sidewinder Maverick; Paveway II, Paveway III, Enhanced Paveway; general purpose bombs
Hawk T 1/1A	632	48,000	AIM 9-L Sidewinder
Jaguar GR3, GR3A	1065	40,000	AIM-9 L; Sidewinder Paveway II, Paveway III, general purpose bombs, CRV-7, Aden 30 mm

(*continued*)

Table 2.6 (continued)

Fighter	*Maximum speed (mph)*	*Ceiling*	*Weapons*
JSF Lightning II	1199	50,000	AIM 120 AMRAAM; AIM 9X Sidewinder; joint air-to-ground missile; joint strike missile; JDAM precision-guided munitions
Tornado GR4	989	50,000	DMS and Legacy Brimstone; Enhanced Paveway II, Storm, Shadow; Paveway III; Paveway IV; Mauser 27 mm cannon; ASRAAM
Typhoon	1370	55,000	Paveway IV, AMRAAM, ASRAAM, Mauser 27 mm cannon; Enhanced Paveway II

Canadian

The Royal Canadian Air Force (RCAF) was established in 1920 as the Canadian Air Force, became RCAF in 1924, was merged into a unified Canadian Defence Forces in 1968, and then became the RCAF again in 2011. RCAF has been closely allied with the United States and NATO and shares responsibilities for the North American Aerospace Defense Command (NORAD) with the United States. These responsibilities are carried out by 12,000 regular personnel, 2100 reserves, and 1500 civilian employees.[29] During its history, the RCAF has experienced success and failures in developing jet fighter programs, with the Avro Arrow program of the late 1950s representing a failed program. Canada has had some success in developing a defense aerospace industry and attempts to keep up with US technological and military interoperability operations while not providing sufficient financial support to its military forces. Canada is facing the challenges of defending its vast Arctic territorial airspace from increasing Russian assertiveness and seeks to strike a delicate balance between meeting domestic economic, political, and social concerns and maintaining its role as a critical player in North American defense and strategic planning.[30] Examples of jet fighters the RCAF has purchased or attempted to purchase are shown in Table 2.7.

China

Chinese jet fighters are flown by the People's Liberation Army Air Force (PLAAF) and People's Liberation Army Navy (PLAN). PLAAF was established as a branch of the People's Liberation Army following the successful 1949 Communist revolution. As of 2017, PLAAF personnel were estimated

Table 2.7 RCAF jet fighter purchases[31]

Fighter	*Maximum speed (mph)*	*Ceiling*	*Weapons*
Bae-Ct-155 Hawk	638	44,500	1 × 30 mm Aden cannon; 4 AIM Sidewinder or ASRAAM
Canadair CF-104 Starfighter	1146	50,000	1 × 20 mm M61A1 Vulcan cannon; external bombs, rockets, and missiles
CF-100 Canuck	552	45,000	2 wingtip pods of 29 × 70 mm "Mighty Mouse" infolding aerial rockets
CF-188 Hornet (popularly known as CF-18)	1370	49,212	Air-to-air: AIM 9M IR guided missile AIM 7 radar-guided missile; AIM 120 radar-guided missile; 20 mm canon air-to-ground: Mk 82< Mk 83, Mk 84, GBU 10, 12, 16, and 24 laser
F-101B Voodoo	1134	58,400	4 AIM 4 Falcon missiles; or 2 air 2 Genie nuclear rockets

to number 398,000, with 2307 combat-capable aircraft. A US Air Force National Air and Space Intelligence Center assessment of PLAAF's history says it has gone through four phases during its recent history:

- Founding Period 1949–1953: Participation in the Korean War and building up its organizational structure.
- Overall Development Period 1954–1966: Merging the People's Liberation Army (PLA) Air Defense force in to PLAAF (1957); creating surface-to-air missile (SAM) forces in 1958; expanding headquarters structures; and establishing regional headquarters and air corps across China; territorial defense against American and Taiwanese manned and unmanned craft.
- Cultural Revolution Period 1966–1976: Deploying units to Vietnam; 1971 Lin Biao coup attempt; air defense in Laos; expanding numbers and closing down of schools due to revolutionary turmoil.
- Modernization Period 1976–Present: Force modernization and professionalization; development of indigenous aerospace industry, purchase of advanced arms from Russia; 1979 Sino-Vietnam border conflict; increasing assertiveness in South and East China Seas.[32]

PLAN was also established in 1949. It includes an aerial arm including maritime strike aircraft, an aircraft carrier, and is developing an anti-ship ballistic missile to defeat US carrier strike groups. In 2016, PLAN personnel were estimated to be 235,000, with 26,000 of these being in naval aviation and an arsenal of 348 combat-capable aircraft. PLAN would play a critical role in any invasion of Taiwan and is already involved in China's increasing international assertiveness as demonstrated by its participation in anti-piracy patrols in the Gulf of Aden, protecting sea lines of communication and in seeking to claim territories in the South and East China Seas and preserving Beijing's access to fishing resources and potentially large natural gas and oil reserves.[33]

Lack of transparency by China about its aircraft capabilities and the intelligence challenges of gathering such data make finding reliable information about recent Chinese jet fighter specifications and technical capabilities problematic. Examples of historical and contemporary jet fighters in PLAAF and PLAN inventories produced by indigenous companies such as Chengdu in Sichuan Province and Shenyang in Liaoning Province, sometimes for foreign export, or purchased from abroad from locales as diverse as Israel and Russia and reengineered are shown in Table 2.8.

Table 2.8 Chinese Air Force and Navy jet fighters[34]

Fighter	*First flight*	*Maximum speed (mph)*	*Ceiling*	*Weapons*
H-6H	1998	631	42,980	2 23mm AM-23 guns, bomb load of up to 19,841 lbs in weapons bay, cruise missile pylons
J-6	1958	957	58,700	3 × 30 mm NR-30 cannons (70 rounds per gun for wing guns, 55 rounds for fuselage gun); up to 550 lbs unguided rocket bombs
J-7	1966	1375	57,420	2 × 30 mm Type 30-1 cannon; 60 rounds per gun; 55 mm rocket pod 12 rounds; PL-7, PL-8 missiles, 50 kg-kg unguided bombs
J-10	1998	1676	59,055	PL 11/12 air-to-air missiles; PJ-9 and YJ-9K ASMs; LT-2 1000 lbs LGB; FT-1, 1000 lbs satellite-guided bomb
J-11	1998	1550	62,523	PL 8/9/12 missiles; free-fall cluster bombs
J-15	2009	1585	65,700	PL 8/12/15 air-to-air missiles; KD-88 ASMs; YJ-83 k anti-ship; and YJ091 anti-radar. Estimated max weapon load of 6500 kg (14,200 lbs)
J-20	2011	1305	59,055	PL-10 ASRAAM; PL-12 medium-range AAM
J-31	2012	1334	Unknown	Twin internal weapons
JH-7	1988	1122	51,180	PL 5/8/9 AA missiles; Yingji 8-k anti-ship missiles; CM 802-A ASMs; GB 1/5 LGBs
Su-27	1977	1550	62,523	1 × 30 mm GSH-30-1 cannon 150 rounds; 2 short-range heat-seeking AA missiles; 6 medium-range R-27 AA missiles
SU-30 MKK	1989	1320	56,800	6 R-27 AAMs; 6 Kh-P31/a anti-ship missiles; 6 KAB 500 KR bombs; nuclear capable

Soviet Union/Russian Federation

Soviet and Russian military jet fighters experienced considerable success during the Soviet era, collapsed during the early years following the Soviet Union's collapse, and are experiencing some resurgence in recent years due to increased Russian military spending derived from higher energy sector sales. Russian jet fighters are sold to many countries outside of Western security architectures such as China and they have contributed to increased Russian military assertiveness against NATO countries, in the Arctic, and Middle East during Vladimir Putin's presidency.[35]

The Russian Federation's Air Force was estimated to include 150,000 personnel as of 2017 and its overall combat aircraft are estimated to number 1090. Its naval aviation personnel are calculated at 31,000 with 205 combat-capable aircraft though the reliability of how many Russian aircraft there actually are is questionable due to the lack of transparency of Russian military statistics and the challenges of acquiring accurate intelligence on these aircraft. Russia military has slowly moved from low- to high-tech, mass conscript to professional, and from mass to mobility. While the Russian military is capable of developing high-tech weapons capable of competing with the United States and its allies there is genuine debate as to how effective Russian aircraft would be in combat situations involving the United States and its allies and whether the Russian military industry is technologically competitive with Western aerospace industries. Russian capacity to continually produce cutting-edge fighters like the Su-35 is questionable due to uncertain domestic production facilities and Western economic sanctions against Russia for its actions in Crimea and Ukraine.[36]

Examples of historic Soviet and contemporary Russian jet fighters made by companies such as Mikoyan and Gurevich (MiG) (now Russian Aircraft Corporation, near Moscow) and Sukhoi in Moscow are given in Table 2.9.

Table 2.9 Soviet/Russian jet fighters[37]

Fighter	*First flight*	*Maximum speed (mph)*	*Ceiling*	*Weapons*
MiG-15	1947	658	50,853	2 × NR-23 23 mm cannon; 1 Nudelman NR-37 37 mm cannon; 2220 lbs bombs
MiG-21	1956	1351	58,400	One internal 23 mm GSh-23 cannon; 4 R-60 m AAM; 2 1102 lbs bombs
MiG-23	1967	1505	60,695	1 GSh-23L 23 mm cannon with 200 rounds; R 23/24 AAM; R-77 AAM

(*continued*)

Table 2.9 (continued)

Fighter	*First flight*	*Maximum speed (mph)*	*Ceiling*	*Weapons*
MiG-25	1964	2170	67,915	2 x radar-guided R-40r AAMs; 2 x infrared guided R-40T missiles
MiG-29	1977	1490	59,100	1 × 30 mm GS-h1 cannon with 150 rounds; up to 7720 lbs of weapons including six AAMs; including a mix of semi-active radar homing missiles
MiG-31	1975	1860	67,600	1 × GS-h 6-23 23 mm cannon with 600 rounds' 6 RS-37 long-range missiles 280 km; Kh-58 anti-radiation missiles
Su-15	1962	1386	59,383	2 × R-98 medium-range AAMs; 2 or 4 R-60 short-range AAMs
Su-33	1987	1.430	55,800	1 × 30 mm GSH-30-1 cannon with 150 rounds; 6 × R-27 AAMs; Moskit anti-ship missile; electronic countermeasure (ECM) pods
Su-35	2007	1485	59,060	1 × 30 mm GSH-30 gun with 150 rounds; 5 RVV-BD AAMs, 5 KH-59 MK ASMs; 8 KAB-500Kr guided bombs
Su-57 T-50 PAK-FA	2017	1520	65,000	1 × 30 mm GSH-30-1 cannon; 4 K-77M AAMs; 4 Kh-38 m air-to-ground missiles; 4 Kh-35 air-to-sea missiles

Conclusion

All of these countries have sought to take advantage of jet technology and other advanced aerospace technologies to develop fighter aircraft capable of meeting their national security requirements at given points in time. These countries have also sought to develop domestic aerospace industries and provide them with economic incentives to produce jet fighters for domestic militaries and approved international military markets. In addition, these countries have also, to varying degrees, demonstrated the political will to sustain increasingly costly financial contributions to support these industries and technologies over several decades even as unmanned aerial weapons systems have become more prominent in the twenty-first century's inaugural decades. The continued willingness of Western countries to sustain these commitments and expenditures is uncertain.[38]

A 2017 study by National Defense University's Eisenhower School for National Security and Resource Strategy contends that the US aerospace and defense sector will become increasingly dependent on international arms sales to sustain its viability. It goes on to maintain that the fighter aircraft market is currently on a structural trajectory toward long-term market failure due to high barriers for new market entrants and the high capital requirements for increasingly complex technologies; substitute defense products in defense aerospace being implausible with drones not advancing to being operationally viable in hostile combat environments; buyers having significant bargaining power since the fighter aircraft customer base is limited to sovereign states with only a few of these being financially capable of producing fourth or fifth-generation fighters; and suppliers having alternatives with fighter producers being able to compete in other defense industries and various non-defense manufacturing and software industries.[39]

This assessment also maintains that Lockheed Martin is the only Euro-Atlantic manufacturer currently developing or producing a fifth-generation fighter and that, since these countries are unlikely to buy such fighters from potential adversaries like Russia or China, there may be no realistic alternative to them but the JSF. Consequently, to sustain this industry's long-term viability, US and other Western aerospace defense firms must focus on exports; emphasize services such as maintaining, rebuilding, and continuously upgrading existing systems; focus on information such as providing multiple software upgrades to fielded systems at lesser cost than developing new systems; focus on mitigating risk by sharing partnerships and as a means of opening foreign sales markets; and stressing incremental innovation and limited research and development since the high risk of winner-take-all-firms provides limited incentive to invest in major technological advances.[40]

The next chapter focuses on geopolitical and technological factors driving the United States and other countries to maintain their interest in jet fighter aircraft during this century's second decade. It also covers potential operational combat scenarios in which the JSF may be used.

Notes

1. See J.D. Kenneth Boutin, "Appendix 1: Key Defense-Industrial and Arms Trade Related Terms," in Richard A. Bitzinger, ed., *The Modern Defence Industry: Political, Economic, and Technological Issues*, (Santa Barbara: Praeger Security International, 2009): 307–308; and Royal Australian Air Force Air Power Development Centre, *Pathfinder Bulletin 170* (January 2012): 1–2; http://airpower.airforce.gov.au/APDC/media/PDF-Files/Pathfinder/PF170-Five-Generations-of-Jet-Fighter-Aircraft.pdf; Accessed December 18, 2017.
2. *Pathfinder Bulletin*, Ibid.

3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.
7. Sainu Kanikara, *The Bolt from the Blue*: *Air Power in the Cycle of Strategies*, (Canberra: Air Power Development Centre, 2013): http://airpower.airforce.gov.au/Publications/The-Bolt-From-the-Blue; Accessed December 18, 2017.
8. Mark A. Lorell and Hugh P. Leveaux, *The Cutting Edge: A Half Century of U.S. Fighter Aircraft R&D*, (Santa Monica, CA: Rand Corporation, 1998): 33; http://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR939.pdf; Accessed May 25, 2018.
9. See Ibid., 30, A.D. Harvey, "German Aircraft Design During the Third Reich," *Air Power History*, 61 (2)(Summer 2014): 28–35.
10. Public Law 80–253, "National Security Act of 1947," 61 *U.S. Statutes at Large*, 502–504; http://legisworks.org/congress/80/publaw-253.pdf; Accessed December 18, 2017.
11. See U.S. Department of State, *Foreign Relations of the United States 1952–1954, National Security Affairs, Volume II, Part 1,* Lisle H. Rose and Neil A. Petersen, eds. (Washington, DC: GPO, 1979): http://history.state.gov/historicaldocuments/frus1952-54v02p1; Accessed February 6, 2017, Lorell and Leveaux, 51; Richard M. Leighton and Raymond Millen, *History of the Office of the Secretary of Defense: Volume III: Strategy, Money, and the New Look, 1953–1956*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2001): http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol3.pdf; Accessed February 6, 2017; *Providing the Means of War: Historical Perspectives on Defense Acquisition, 1945–2000*, Shannon A. Brown, ed., (Washington, DC: United States Army Center for Military History and Industrial College of the Armed Forces, 2005): http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMHPub70-87-1ProvidingtheMeans.pdf; Accessed February 6, 2017; Millen, "Cultivating Strategic Thinking: The Eisenhower Model," *Parameters*, 42 (2)(Summer 2012): 56–70; http://ssi.armywarcollege.edu/pubs/parameters/articles/2012summer/Millen.pdf; and Jeffrey S. Underwood, "Presidential Statesmen and U.S. Airpower: Personalities and Perceptions," in *The Influence of Airpower Upon History: Statesmanship, Diplomacy, and Foreign Policy Since 1903*, Robin Higham and Mark Parillo, eds., (Lexington: University Press of Kentucky, 2013): 192–193.
12. See Lorell and Leveaux, 52; and Measuringworth.com; Accessed February 7, 2017; for conversion to 2015 CPI rates.

13. See Ibid, 53–87; Roger E. Bilstein, *Orders of Magnitude: A History of the NACA and NASA, 1915–1990*, (Washington, DC: NASA, 1989); http://history.nasa.gov/SP-4406/contents.html; Accessed February 7, 2017; Robert J. Watson, *History of the Office of the Secretary of Defense: Volume IV: Into the Missile Age, 1956–1960*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 1997): http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol4.pdf; Accessed May 14, 2017; and Thomas C. Lassman, *Sources of Weapons Systems Innovation in the Department of Defense: The Role of In-House Research and Development, 1945–2000*, (Washington, DC: United States Army Center of Military History, 2008); http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_51-2-1.pdf; Accessed February 7, 2017.
14. See Lorell and Leveaux, 89–90; Robin Higham, *100 Years of Air Power & Aviation*, (College Station: Texas A&M University Press, 2004): 245–258; Lawrence S. Kaplan, Ronald D. Landa, and Edward J. Drea, *History of the Office of the Secretary of Defense: Volume V: The McNamara Ascendancy, 1961–1965*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2006): http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol5.pdf; Accessed February 9, 2017; Edward J. Drea, *History of the Office of the Secretary of Defense: Volume VI: McNamara, Clifford, and the Burdens of Vietnam 1965–1969*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2011): http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol6.pdf; Accessed February 9, 2017; and Walter S. Poole, *History of Acquisition in the Department of Defense: Adapting to Flexible Response, 1960–1968*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2013): 179–248; http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol2.pdf; Accessed February 9, 2017.
15. See Lorell and Levaux, 52; Marcelle Size Knaack, *Encyclopedia of U.S. Air Force Aircraft and Missile Systems: Volume I*, (Washington, DC: Office of Air Force History, 1978): 293–297; http://media.defense.gov/2010/May/26/2001330287/-1/-1/0/AFD-100526-027.pdf; Accessed February 7, 2017; U.S. Air Force, *Air Force Fact Sheets*, (Washington, DC: U.S. Air Force, 2015): http://www.af.mil/AboutUs/FactSheets.aspx; Accessed February 9, 2017; *Naval Aviation 1911–1986: A Pictorial Study*, Sandy Russell and Staff of Aviation News, eds., (Washington, DC: Deputy Chief of Naval Operations (Air Warfare) and Commander, Naval Air Systems Command, 1986): https://www.history.navy.mil/content/dam/nhhc/research/publications/Publication-PDF/NavalAviation1911-1986.pdf; Accessed February 7, 2017; Gordon Swanborough and Peter M. Bowers, *United States Military Aircraft Since 1909*, (Washington, DC: Smithsonian Books, 1989); and measuringworth.com; Accessed February 7, 2017.

16. See Richard H. Shultz, Jr. and Robert F. Pfaltzgraff, Jr., *The Future of Airpower in the Aftermath of the Gulf War*, (Maxwell AFB, AL: Air University Press, 1992); http://aupress.maxwell.af.mil/digital/pdf/book/b_0048_shultz_future_of_airpower.pdf; Accessed March 15, 2017; Richard T. Reynolds, *Heart of the Storm: The Genesis of the Air Campaign Against Iraq*, (Maxwell, AFB, AL: Air University Press, 1995): http://aupress.maxwell.af.mil/digital/pdf/book/b_0055_reynolds_heart_storm1.pdf; Accessed March 15, 2017; Benjamin S. Lambeth, *The Transformation of American Air Power*, (Ithaca: Cornell University Press, 2000); David R. Mets, *The Long Search for Surgical Strike: Precision Guided Munitions and the Revolution in Military Affairs*, (Maxwell AFB, AL: Air University Press, 2001): http://purl.access.gpo.gov/GPO/LPS37565; Accessed March 15, 2017; Michael Russell Rip and James M. Hasik, *The Precision Revolution: GPS and the Future of Aerial Warfare*, (Annapolis, MD: Naval Institute Press, 2002); Paul G. Gillespie, *Weapons of Choice: The Development of Precision Guided Munitions*, (Tuscaloosa: University of Alabama Press, 2006); and Colin S. Gray, *Airpower for Strategic Effect*, (Maxwell AFB, AL: Air University Press, 2012): http://aupress.maxwell.af.mil/digital/pdf/book/b_0122_gray_airpower_strategic_effect.pdf; Accessed March 15, 2017.
17. Lorell and Leveraux, 129.
18. See Ibid., 170–199; and www.measuringworth.com/; Accessed February 7, 2017; Tom Martin and Rachel Schmidt, *A Case Study of the F-20 Tigershark*, (Santa Monica: Rand Graduate School, 1987); http://www.rand.org/content/dam/rand/pubs/papers/2009/P7495.pdf; Accessed May 18, 2017; *Air Force Fact Sheets*, Accessed April 18, 2015; and "Tomcats Officially Retire," (Washington, DC: United States Navy, 2006): 1; http://www.navy.mil/submit/display.asp?story_id=25747; Accessed February 7, 2017.
19. See Lorell and Leveraux, 149–153; Anthony L. Velocci, Jr., "Further Consolidation Looms Over Industry: Many More Mergers and Acquisitions Will Occur Including One or Two 'Elephant Deals' Worldwide," *Aviation Week and Space Technology*, 152 (19)(May 8, 2000): 22–24.; Judy B. Davis, "The Impact of Defense Industry Consolidation on the Aerospace Industry," Thesis, (Wright-Patterson, AFB: Air Force Institute of Technology, 2006); http://handle.dtic.mil/100.2/ADA449606; Accessed March 18, 2017; and U.S. Congress, Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operation, Safety, and Security, *The Global Competitiveness of the U.S. Aviation Industry: Addressing Issues to Maintain U.S. Leadership in the Aerospace Market*, (Washington, DC: GPO, 2014); http://purl.fdlp.gov/GPO/gpo46733; Accessed March 18, 2017.
20. "Ageing Array of American Aircraft Attracting Attention," *Defense Industry Daily*, (September 15, 2015): 1; http://www.defenseindustrydaily.com/aging-array-of-american-aircraft-attracting-attention-0901/; Accessed February 7, 2017.

21. Mackenzie Eaglen, *The State of the U.S. Military*, (Washington, DC: The Heritage Foundation, 2010): 1; http://s3.amazonaws.com/thf_media/2010/pdf/Military_chartbook.pdf; Accessed May 18, 2017.
22. *2015 Index of U.S. Military Strength: Assessing America's Ability to Provide for the Common Defense*, Dakota L. Wood, ed., (Washington, DC: The Heritage Foundation, 2015): 253–258; http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf; Accessed May 18, 2017.
23. See U.S. Congress, House Committee on Armed Services, Subcommittee on Investigations, *Review of Arms Coproduction Agreements*, (Washington, DC: GPO, 1989); Modern *Defense Industry: The Political, Economic, and Technological Issues*, Richard A. Bitzinger, ed., (Santa Barbara: ABC-CLIO, 2009); 153–242; Peter Hall and Andrew D. James, *Defence Industrial Policies and Their Impact on Acquisition Outcomes: A Comparative Analysis of the United Kingdom and Australia*, (Canberra: Institute for New South Wales, School of Business, 2012): http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA581951; Accessed May 18, 2017; and Lawrence Spinetta, "The Life Cycle of Manned Aircraft," *International Journal of Defense Acquisition Management*, 6 (2014): 21–37.
24. See Royal Australian Air Force, "History," (Canberra: Royal Australian Air Force, 2015): 1–2; http://www.airforce.gov.au/History/?RAAF-Sq7iGFssX2/HNFhOlsw4TP9fITfYhI7O; Accessed February 7, 2017; Ibid., *Air Force Bases*, n.d., 1–2; http://www.airforce.gov.au/RAAFBases/?RAAF-EYD01E6ZiPbV0Cl+C+GKu4PSUCVwrBfQ; Accessed December 18, 2017; and Australia, Department of Defence, *Defence Annual Report 2016–17: Volume One: Performance, Governance, and Accountability*, (Canberra: Department of Defence, 2017); 91; http://www.defence.gov.au/annualreports/16-17/Downloads/DAR_2016-17_Complete.pdf; Accessed December 18, 2017).
25. See Alan Stephens, *Power Plus Attitude: Ideas, Strategy, and Doctrine in the Royal Australian Air Force, 1921–1991*, (Canberra: Australian Government Publishing Service, 1992); http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical%20Publications/HIST02-Power-Plus-Attitude-Ideas,-Strategy-and-Doctrine-in-the-Royal-Australian-Air-Force,-1921-1991.pdf; Accessed May 18, 2017; Alan Stephens, *The Royal Australian Air Force*, (South Melbourne: Oxford University Press, 2001); Sainu Kainikara and Tony Forestier, *Air Power for Australia's Security: More Than the Three Block War*, (Canberra: RAAF Airpower Centre, 2007); http://airpower.airforce.gov.au/APDC/media/PDF-Files/CAF%20Occasional%20Papers/CAF01-Air-Power-for-Australia-s-Security-More-Than-the-Three-Block-War.pdf; Accessed May 18, 2017; and Mark Lax, *From Controversy to Cutting Edge: A History of the F-111 in Australian*

Service, (Canberra: RAAF Airpower Development Centre, 2010); http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical%20Publications/HIST22-From-Controversy-to-Cutting-Edge-A-History-of-the-F-111-in-Australian-Service.pdf; Accessed April 18, 2017.

26. See Alan Stephens, *Going Solo: The Royal Australian Air Force, 1946–1971*, (Canberra: Australian Government Publishing Service, 1995); http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical%20Publications/HIST03-Going-Solo-The-Royal-Australian-Air-Force-1946-1971.pdf; Accessed February 7, 2017; Royal Australian Air Force, *Aircraft*, (Canberra: Royal Australian Air Force, 2015); Accessed May 18, 2017; RAAF Museum, *RAAF Aircraft*, (Point Cook, VIC: RAAF Museum, 2015); https://www.airforce.gov.au/sites/g/files/net3736/f/minisite/static/1469/RAAFmuseum/photo_album/aircraft.htm; Accessed May 30, 2018; and U.S. Air Force Museum, "North American F-86A Sabre," (Dayton, OH: U.S. Air Force Museum, 2015): 1; http://www.nationalmuseum.af.mil/Visit/MuseumExhibits/FactSheets/Display/tabid/509/Article/198071/north-american-f-86h-sabre.aspx; Accessed February 7, 2017.
27. See United Kingdom, "First World War in the Air," (London: Royal Air Force Museum, 2015): 1; https://www.rafmuseum.org.uk/london/whats-going-on/events/opening-of-first-world-war-in-the-air-exhibition/. Accessed May 30, 2018; David J. Dean, *Airpower in Small Wars: The British Air Control Experience*, (Maxwell AFB, AL: Air University Press, 1985); Owen Gordon Thetford, *Aircraft of the Royal Air Force Since 1918*, 9th ed., (London: Putnam, 1995); Peter Foster, *Tornado ADV: The Last Cold War Interceptor*, (Stroud: History Press, 2011); Chris Gibson, *Battle Flight: RAF Air Defence Projects and Weapons Since 1945*, (Manchester: Hikoki Publications, 2012); *Air Power Review*, Special Edition, Spring 2013, http://www.airpowerstudies.co.uk/sitebuildercontent/sitebuilderfiles/apr-95th-anniversary.pdf; Accessed May 19, 2017; United Kingdom, Ministry of Defence, *UK Armed Forces Monthly Service Personnel Statistics 1 October 2017*, (London: Ministry of Defence, 16 November 2017): 3–4; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/659404/20171001_-_SPS.pdf; Accessed December 18, 2017); and Changing *War: The British Army, the Hundred Days Campaign, and the Birth of the Royal Air Force*, Gary Sheffield and Peter Gray, eds., (London: Bloomsbury Academic, 2015).
28. See Royal Air Force, "Aircraft," (London: RAF, 2015): https://www.raf.mod.uk/aircraft/; Accessed May 30, 2018; and *Royal Air Force: Weapons*, (London: RAF, 2018): https://www.raf.mod.uk/search-results/?Keywords=weapons&display=search&newSearch=true&noCache=1. Accessed May 30, 2018.

29. Royal Canadian Air Force, "Overview," (Ottawa: Royal Canadian Air Force, 2016): 1–2; http://www.rcaf-arc.forces.gc.ca/en/overview.page; Accessed December 18, 2017.
30. See Canada, Parliament, *House of Commons Debates*, 24th Parliament, 2nd Sess., February 20, 1959, 2:1221–1224; http://parl.canadiana.ca/view/oop.debates_HOC2402_02/6?r=0&s=2; Accessed May 19, 2017; W.A.B. Douglas, *The Official History of the Royal Canadian Air Force*, (Ottawa and Toronto: Department of National Defence and University of Toronto Press, 1980); Brereton Greenhous, *Canada's Air Forces 1914–1999*, (St. Catherine's, ON: Vanwell Pub. Ltd., 2004); Dwight N. Mason, "The Canadian-American North American Defence Alliance in 2005," *International Journal*, 60 (2)(Spring 2005): 85–96; https://doi.org/10.2307/40204296; Palmiro Campagna, *Storms of Controversy: The Secret Avro Arrow Files Revealed*, (Toronto: Dundurn, 2010); Canada, Chief of Defence Intelligence, *Threat Capability Assessment for Canada's Fighter Aircraft Capability*, (Ottawa: Chief of Defence Intelligence, 2012): http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2006%20Task%201%20(En)%20final.pdf; Accessed May 19, 2017; Lawrence Miller, *The Avro Arrow: The Story of the Great Canadian Cold War Combat Jet-In Pictures and Documents*, (Toronto: Lorimer, 2014); and John Alexander, "A Return to the Royal Canadian Air Force Ranks: A Historical Examination," *The Royal Canadian Air Force Journal*, 3 (1)(Winter 2014): 5–14; http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss1-03-a-return-to-royal-canadian-air-force-ranks-a-historical-examination.pdf; Accessed May 19, 2017.
31. See Maureen Cronin, "A Case of Hornets: The Controversial CF-18," *American Review of Canadian Studies*, 12 (3)(1982): 17–28; https://doi.org/10.1080/02722018209480755; John Fricker, "British Aerospace Hawk," *World Air Power Journal*, 22 (Fall/Autumn 1995): 45–111; Ray Stouffer, "Cold War Air Power Choices for the RCAF: Paul Hellyer and the Selection of the CF-5 Freedom Fighter," *Canadian Military Journal*, 7 (3) (Autumn 2006): 63–74; http://www.journal.forces.gc.ca/vo7/no3/doc/stouffer-eng.pdf; Accessed May 19, 2017; Canadian Warplane Heritage Museum, "AVRO CANADA CF-100 CANUCK MK. 5D," (Mount Hope, ON: Canadian Warplane Heritage Museum, 2015): 1; http://www.warplane.com/vintage-aircraft-collection/aircraft-history.aspx?aircraftId=3; Accessed May 19, 2017; Royal Canadian Air Force, "CF-188 Hornet," (Ottawa: Royal Canadian Air Force, 2015): 1–2; http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cf-188.page; Accessed May 19, 2017; Dave Perry, *A Primer on Recent Canadian Defence Budgeting Trends and Implications*, (Calgary: University of Calgary School of Public Policy *SPP*

Research Papers, 8 (15)(April 2015): http://www.policyschool.ca/wp-content/uploads/2016/03/canadian-defence-budgeting-perry.pdf; Accessed February 7, 2017; and U.S. Air Force Museum, "McDonnell F-101B Voodoo," (Dayton: National Museum of the U.S. Air Force, 2015): 1; Accessed May 19, 2015; http://www.nationalmuseum.af.mil/Visit/MuseumExhibits/FactSheets/Display/tabid/509/Article/196899/mcdonnell-f-101b-voodoo.aspx; Accessed February 7, 2017.

32. See U.S. National Air and Space Intelligence Center, *People's Liberation Army Air Force 2010*, (Wright-Patterson AFB, OH: U.S. National Air and Space Intelligence Center, 2010): 11–18; http://www.au.af.mil/au/awc/awcgate/nasic/pla_af_2010.pdf; Accessed May 21, 2017; *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, Richard P. Hallion, Roger Cliff, and Phillip G. Saunders, eds., (Washington, DC: National Defense University Press, 2012); http://ndupress.ndu.edu/Portals/68/Documents/Books/chinese-air-force.pdf; Accessed May 21, 2017; Anthony H. Cordesman and Nicholas S. Yarosh, *Chinese Military Modernization and Force Development: A Western Perspective*, (Washington, DC: Center for Strategic and International Studies, 2012): 135; http://csis.org/files/publication/120727_Chinese_Military_Modernization_Force_Dvlpment.pdf; Accessed May 21, 2017; and International Institute of Strategic Studies, *Military Balance 2017*, (London: IISS, 2016): 270–284.

33. See U.S. Office of Naval Intelligence, *The People's Liberation Army Navy: A Modern Navy With Chinese Characteristics*, (Suitland, MD: Office of Naval Intelligence, 2009): 5–11; http://fas.org/irp/agency/oni/pla-navy.pdf; Accessed May 21, 2017; Philip C. Saunders, *The Chinese Navy: Expanding Capabilities, Evolving Roles*, (Washington, DC: National Defense University Press, 2012): http://purl.fdlp.gov/GPO/gpo19516; Accessed May 21, 2017; Cordesman and Yarosh, 113, 116–117, 2015; Christopher H. Sharman, *China Moves Out: Stepping Stones Toward a New Maritime Strategy*, (Washington, DC: National Defense University Press, 2015); http://purl.fdlp.gov/GPO/gpo57396; Accessed May 21, 2017; and *Military Balance 2017*, 281, 283.

34. See Evan S. Medeiros, Roger Cliff, Keith Crane, and James C. Mulvenon, *A New Direction for China's Defense* Industry, (Santa Monica: Rand Corporation, 2005): http://www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG334.pdf; Accessed May 21, 2017; Tai Ming Cheung, *The J-20 Fighter Aircraft and the State of China's Defense Science, Technology, Innovation, and Potential*, (Berkeley: University of California Institute on Global Cooperation and Conflict, 2011); https://escholarship.org/uc/item/6q33s2sm; Accessed May 21, 2017; Bill Sweetman, "Unique J-20 Could Fit Anti-Access Role, "*Aviation Week and Space Technology*, 176 (39)(November 3, 2014): 57–59; Kevin Pollpeter,

"Introduction to SITC Policy Briefs," (Berkeley: University of California Institute on Global Cooperation and Conflict, 2014); https://escholarship.org/uc/item/3w58q0s2; Accessed May 21, 2017; and *Jane's All the World's Aircraft: Development and Production*, (Washington, DC: IHS, 2015).

35. See Olga Oliker and Tanya Charlick-Paley, *Assessing Russia's Decline: Trends and Implications for the United States and the U.S. Air Force*, (Santa Monica: Rand Corporation, 2002); http://www.rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1442.pdf; Accessed May 21, 2017; Thomas McCabe, "Airpower in the Next War: In the Shadow of Georgia," *Air and Space Power Journal*, 23 (4)(Winter 2009): 58–67; http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-23_Issue-1-4/2009_Vol23_No4.pdf; Accessed February 7, 2017; "Russian Fighter Jets Patrolling Ukraine Border," *VOA News*, (February 27, 2014): 1–2; http://www.voanews.com/content/russian-fighter-jets-patrolling-ukraine-border/1860450.html; Accessed May 21, 2017; "DOD News Update: Revanchist Russia Threatens Europe," (Washington, DC: Defense Video & Imagery Distribution System, May 1, 2015); https://www.dvidshub.net/video/401812/dod-news-update-revanchist-russia-threatens-europe#.VV4lK09VhBc; Accessed May 21, 2017; Raymond D. Limbach, "Air Forces, Russia (to 1917, and since 1991)," and "Air Forces, Soviet (1917–1991)," in *Russia at War: From the Mongol Conquest to Afghanistan, Chechnya, and Beyond: Volume 1: A-M,* Timothy C. Dowling, ed., (Santa Barbara: ABC-CLIO, 2015): 1:8–12; and Roland Oliphant, "Mapped: Just How Many Incursions into NATO Airspace Has Russian Military Made?," *Daily Telegraph*, (May 15, 2015); http://www.telegraph.co.uk/news/worldnews/europe/russia/11609783/Mapped-Just-how-many-incursions-into-Nato-airspace-has-Russian-military-made.html; Accessed May 21, 2017.

36. See *Military Balance* 2017, 211–215; Bettina Renz, "Russian Military Capabilities After 20 Years of Reform," *Survival*, 56 (3)(June/July 2014): 61–84; https://doi.org/10.1080/00396338.2014.920145; Aneli Bongers and José L. Torres, "Measuring Technological Trends: A Comparison Between U.S. and U.S.S.R./Russian Jet Fighter Aircraft," *Technological Forecasting and Social Change*, 87 (2014): 125–134; http://dx.doi.org/10/1016/j.techfore.2013.12.007; Maggie Marcum, *A Comparative Study of Global Fighter Development Timeslines*, (Berkeley: University of California Institute on Global Cooperation and Conflict, 2014): https://escholarship.org/uc/item/1wm202sh; Accessed May 21, 2017; Robert Beckhusen, "Russia's Air Corps is a Powerful but Fading Force," *Reuters,* (March 18, 2015): 1–3; http://www.reuters.com/article/beckhusen-russiannavy-idUSL2N0WM1EE20150320; Accessed February 7, 2017; and Ray Finch, "Modernization Challenges in Key Russian Fighter," *OE Watch,* 5 (3)(March 2015): 63–64; https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195461; Accessed May 21, 2017.

37. *Jane's All the World's Aircraft*, Bongers and Torres, 133; Robin Higham, John Greenwood, and Von Hardesty, *Russian Aviation and Air Power in the 20th Century*, (London: Frank Cass, 1998); Xiaoming Zhang, *Red Wings Over the Yalu: China, the Soviet Union, and the Air War in Korea*, (College Station: Texas A&M University Press, 2002).
38. See Jeff Carter and Glenn Palmer, "Keeping the Schools Open While the Troops are Away: Regime Type, Interstate War, and Government Spending," *International Studies Quarterly*, 59 (1)(March 2015): 145–157; https://doi.org/10.1111/isqu.12160; Larry Williams, "Estimating the Defense Spending Vote," *Electoral Studies*, 39 (September 2015): 243–255; http://dx.doi.org/dx.doi.org/10.1016/j.electstud.2015.03.020; and Gallup Organization. Gallup Poll, Feb, 2015 [survey question]. USGALLUP.022015.R01. Gallup Organization [producer]. Storrs, CT: Roper Center for Public Opinion Research, iPOLL [distributor], accessed May-22-2017.
39. *Spring 2017 Industry Study: Final Report Aircraft Industry*, (Washington, DC: The Dwight D. Eisenhower School for National Security and Resource Strategy, National Defense University, 2017): 1, 6; http://es.ndu.edu/Portals/75/Documents/industry-study/reports/2017/es-is-report-aircraft-2017.pdf; Accessed May 25, 2018.
40. Ibid., 8, 86.

References

2015 Index of U.S. Military Strength: Assessing America's Ability to Provide for the Common Defense. Edited by Dakota L. Wood, ed. (Washington, DC: The Heritage Foundation, 2015): 253–258. http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf. Accessed May 18, 2017.

Ageing Array of American Aircraft Attracting Attention. *Defense Industry Daily* (September 15, 2015): 1. http://www.defenseindustrydaily.com/aging-array-of-american-aircraft-attracting-attention-0901/. Accessed February 7, 2017.

Air Power Review. Special Edition (Spring 2013). http://www.airpowerstudies.co.uk/sitebuildercontent/sitebuilderfiles/apr-95th-anniversary.pdf. Accessed May 19, 2017.

Alexander, John. "A Return to the Royal Canadian Air Force Ranks: A Historical Examination." *The Royal Canadian Air Force Journal*, 3 (1) (Winter 2014): 5–14. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss1-03-a-return-to-royal-canadian-air-force-ranks-a-historical-examination.pdf. Accessed May 19, 2017.

Australia. Department of Defence. *Defence Annual Report 2016–17: Volume One: Performance, Governance, and Accountability* (Canberra: Department of Defence, 2017): 91. http://www.defence.gov.au/annualreports/16-17/Downloads/DAR_2016-17_Complete.pdf. Accessed December 18, 2017.

Beckhusen, Robert. “Russia’s Air Corps is a Powerful but Fading Force.” *Reuters* (March 18, 2015): 1–3. http://www.reuters.com/article/beckhusen-russian-navy-idUSL2N0WM1EE20150320. Accessed February 7, 2017.

Bilstein, Roger E. *Orders of Magnitude: A History of NACA and NASA, 1915–1990*. (Washington, DC: NASA, 1989). http://history.nasa.gov/SP-4406/contents.html. Accessed February 7, 2017.

Bongers, Aneli, and José L. Torres. “Measuring Technological Trends: A Comparison Between U.S. and U.S.S.R./Russian Jet Fighter Aircraft.” *Technological Forecasting and Social Change*, 87 (2014): 125–134. http://dx.doi.org/10/1016/j.techfore.2013.12.007.

Boutin, J.D. Kenneth. “Appendix 1: Key Defense-Industrial and Arms Trade Related Terms.” In *The Modern Defence Industry: Political, Economic, and Technological Issues*, edited by Richard A. Bitzinger, 307–308 (Santa Barbara: Praeger Security International, 2009).

Campagna, Palmiro. *Storms of Controversy: The Secret Avro Arrow Files Revealed* (Toronto: Dundurn, 2010).

Canada. Chief of Defence Intelligence. *Threat Capability Assessment for Canada’s Fighter Aircraft Capability* (Ottawa: Chief of Defence Intelligence, 2012). http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2006%20Task%201%20(En)%20final.pdf. Accessed May 19, 2017.

Canada. Parliament. *House of Commons Debates*. 24th Parliament. 2nd Sess. February 20, 1959. 2: 1221–1224. http://parl.canadiana.ca/view/oop.debates_HOC2402_02/3?r=0&s=2. Accessed May 19, 2017.

Canadian Warplane Heritage Museum. “AVRO-CANADA CF-100 CANUCK. MK. 5D.” (Mount Hope, ON: Canadian Warplane Heritage Museum, 2015): 1. http://www.warplane.com/aircraft/collection/details.aspx?aircraftId=3. Accessed May 19, 2017.

Carter, Jeff, and Glenn Palmer. “Keeping the Schools Open While the Troops Are Away: Regime Type, Interstate War, and Government Spending.” *International Studies Quarterly*, 59 (1) (March 2015): 145–157. https://doi.org/10.1111/isqu.12160.

Changing War: The British Army, the Hundred Days Campaign, and the Birth of the Royal Air Force. Gary Sheffield and Peter Gray, eds. (London: Bloomsbury Academic, 2015).

Cheung, Tai Mei. *The J-20 Fighter Aircraft and the State of China’s Defense Science* (Berkeley: University of California Institute on Global Cooperation and Conflict, 2011). https://escholarship.org/uc/item/6q33s2sm. Accessed May 21, 2017.

The Chinese Air Force: Evolving Concepts, Roles, and Capabilities. Richard P. Hallion, Roger Cliff, and Phillip G. Saunders, eds. (Washington, DC: National Defense University Press, 2012). http://ndupress.ndu.edu/Portals/68/Documents/Books/chinese-air-force.pdf. Accessed May 21, 2017.

Cordesman, Anthony H., and Nicholas S. Yarosh. *Chinese Military Modernization and Force Development: A Western Perspective* (Washington, DC: Center for Strategic and International Studies, 2012): 135. http://csis.org/files/publication/120727_Chinese_Military_Modernization_Force_Dvlpment.pdf. Accessed May 21, 2017.

Cronin, Maureen. "A Case of Hornets: The Controversial CF-18." *American Review of Canadian Studies*, 12 (3) (1982): 17–28. https://doi.org/10.1080/02722018209480755.

Davis, Judy B. "The Impact of Defense Industry Consolidation on the Aerospace Industry." Thesis (Wright-Patterson, AFB: Air Force Institute of Technology, 2006). http://handle.dtic.mil/100.2/ADA449606. Accessed March 18, 2017.

Dean, David J. *Airpower in Small Wars: The British Air Control Experience* (Maxwell, AFB, AL: Air University Press, 1985).

"DOD News Update: Revanchist Russia Threatens Europe." (Washington, DC: Defense Video & Imagery Distribution System, May 1, 2015). https://www.dvidshub.net/video/401812/dod-news-update-revanchist-russia-threatens-europe#.VV4lK09VhBc. Accessed May 21, 2017.

Douglas, W.A.B. *The Official History of the Royal Canadian Air Force* (Ottawa and Toronto: Department of National Defence and University of Toronto Press, 1980).

Drea, Edward J. *History of the Office of the Secretary of Defense: Volume VI: McNamara, Clifford, and the Burdens of Vietnam, 1965–1969* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2011). http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_VOL6.pdf. Accessed February 9, 2017.

Eaglen, Mackenzie. *The State of the U.S. Military* (Washington, DC: The Heritage Foundation, 2010): 1. http://s3.amazonaws.com/thf_media/2010/pdf/Military_chartbook.pdf. Accessed May 18, 2017.

Finch, Ray. "Modernization Challenges in Key Russian Fighter." *OE Watch*, 5 (3) (March 2015): 63–64. https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195461. Accessed May 21, 2017.

Foster, Peter. *Tornado ADV: The Last Cold War Interceptor*. (Stroud: History Press, 2011).

Fricker, John. "British Aerospace Hawk." *World Air Power Journal*, 22 (Fall/Autumn 1995): 45–111.

Gallup Organization. Gallup Poll, Feb, 2015 [survey question]. USGALLUP.022015.R01. Gallup Organization [producer]. Storrs, CT: Roper Center for Public Opinion Research, iPOLL [distributor]. Accessed May 22, 2017.

Gibson, Chris. *Battle Flight: RAF Air Defence Projects and Weapons Since 1945* (Manchester: Hikoki Publications, 2012).

Gillespie, Paul G. *Weapons of Choice: The Development of Precision Guided Munitions* (Tuscaloosa: University of Alabama Press, 2006).

Gray, Colin S. *Airpower for Strategic Effect* (Maxwell AFB, AL: Air University Press, 2012). http://aupress.maxwell.af.mil/digital/pdf/book/b_0122_gray_airpower_strategic_effect.pdf. Accessed March 15, 2017.

Greenhouse, Brereton. *Canada's Air Forces 1914–1999* (St. Catherine's, ON: Vanwell Pub. Ltd, 2004).

Hall, Peter, and Andrew D. James. *Defence Industrial Policies and Their Impact on Acquisition Outcomes: A Comparative Analysis of the United Kingdom and Australia*. (Canberra: Institute for New South Wales, School of Business, 2012). http://www.dtic.mil/dtic/tr/fulltext/u2/a581951.pdf. Accessed May 18, 2017.

Harvey, A.D. "German Aircraft Design During the Third Reich." *Air Power History*, 61 (2) (Summer 2014): 28–35.

Higham, Robin. *100 Years of Air Power & Aviation* (College Station: Texas A&M University Press, 2004): 245–258.

Higham, Robin, John Greenwood, and Von Hardesty. *Russian Aviation and Air Power in the Twentieth Century* (London: Frank Cass, 1998).

https://www.measuringworth.com/. Accessed February 7, 2017 for conversion to recent CPI rates.

International Institute of Strategic Studies. *Military Balance 2017* (London: IISS, 2016): 270–284.

Jane's All the World's Aircraft: Development and Production. (Washington, DC: IHS, 2015).

Kainikara, Sainu, and Tony Forester. *Air Power for Australia's Security: More Than the Three Block War* (Canberra: RAAF Airpower Center, 2007). http://airpower.airforce.gov.au/APDC/media/PDF-Files/CAF Occasional Papers/CAF01-Air-Power-for-Australia-s-Security-More-Than-the-Three-Block-War.pdf. Accessed May 18, 2017.

———. *The Bolt from the Blue: Air Power in the Cycle of Strategies* (Canberra: Air Power Development Centre, 2013). http://airpower.airforce.gov.au/Publications/The-Bolt-From-the-Blue. Accessed December 18, 2017.

Kaplan, Lawrence S., Ronald D. Landa, and Edward J. Drea. *History of the Office of the Secretary of Defense: Volume V: The McNamara Ascendancy, 1961–1965*. (Washington, DC: Historical Office, Office of the Secretary of Defense, 2006). http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol5.pdf. Accessed February 9, 2017.

Knaack, Marcelle Size. *Encyclopedia of U.S. Air Force Aircraft and Missile Systems: Volume I* (Washington, DC: Office of Air Force History, 1978): 293–297. http://media.defense.gov/2010/May/26/2001330287/-1/-1/0/AFD-100526-027.pdf. Accessed February 7, 2017.

Lambeth, Benjamin S. *The Transformation of American Air Power* (Ithaca: Cornell University Press, 2000).

Lassman, Thomas C. *Sources of Weapons Systems Innovation in the Department of Defense: The Role of In-House Research and Development, 1945–2000.* (Washington, DC: United States Army Center of Military History, 2008). http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_51-2-1.pdf. Accessed February 7, 2017.

Lax, Mark. *From Controversy to Cutting Edge: A History of the F-111 in Australian Service* (Canberra: RAAF Airpower Development Centre, 2010). http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical Publications/HIST22-From-Controversy-to-Cutting-Edge-A-History-of-the-F-111-in-Australian-Service.pdf. Accessed April 18, 2017.

Leighton, Richard M., and Raymond Millen. *Historical Office of the Secretary of Defense: Volume II: Strategy, Money, and the New Look, 1953–1956* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2001). http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol3.pdf. Accessed February 6, 2017.

Limbach, Raymond D. "Air Forces, Russia (to 1917), and since 1991)" and "Air Forces, Soviet (1917–1991)." In *Russia at War: From the Mongol Conquest to Afghanistan, Chechnya, and Beyond: Volume 1: A-M.* edited by Timothy C. Dowling (Santa Barbara: ABC-CLIO, 2015): 1: 8–12.

Lorell, Mark A., and Hugh P. Leveaux. *The Cutting Edge: A Half Century of U.S. Fighter Aircraft R&D* (Santa Monica, CA: Rand Corporation, 1998): 33. http://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR939.pdf. Accessed May 25, 2018.

Marcum, Maggie. *A Comparative Study of Global Fighter Development Timelines* (Berkeley: University of California Institute on Global Cooperation and Conflict, 2014). https://escholarship.org/uc/item/1wm202sh. Accessed May 21, 2017.

Martin, Tom, and Rachel Schmidt. *A Case Study of the F-20 Tiger Shark* (Santa Monica: Rand Graduate School, 1987). http://www.rand.org/content/dam/rand/pubs/papers/2009/P7495.pdf. Accessed May 18, 2017.

Mason, Dwight N. "The Canadian-American North American Defence Alliance in 2005." *International Journal*, 60 (2) (Spring 2005): 85–96. https://doi.org/10.2307/40204296.

McCabe, Thomas. "Airpower in the Next War: In the Shadow of Georgia." *Air and Space Power Journal*, 23 (4) (Winter 2009): 58–67. http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-23_Issue-1-4/2009_Vol23_No4.pdf. Accessed February 7, 2017.

Medeiros, Evan S., Roger Cliff, Keith Crane, and James C. Mulvenon. *A New Direction for China's Defense Industry* (Santa Monica: Rand Corporation, 2005). http://www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG334.pdf. Accessed May 21, 2017.

Mets, David R. *The Long Search for Surgical Strike: Precision Guided Munitions and the Revolution in Military Affairs* (Maxwell AFB, AL: Air University Press, 2001). http://purl.access.gpo.gov/GPO/LPS37565. Accessed March 15, 2017.

Millen, Raymond. "Cultivating Strategic Thinking: The Eisenhower Model." *Parameters*, 42 (2) (Summer 2015): 56–70. http://ssi.armywarcollege.edu/pubs/parameters/articles/2012summer/Millen.pdf.

Miller, Lawrence. *The Avro Arrow: The Story of the Great Canadian Cold War Jet-In Pictures and Documents* (Toronto: Lorimer, 2014).

Modern Defense Industry: The Political, Economic, and Technological Issues. Edited by Richard A. Bitzinger (Santa Barbara: ABC-CLIO, 2009: 153–242.

Naval Aviation 1911–1986: A Pictorial Study. Edited by Sandy Russell and Staff of Aviation News. (Washington, DC: Deputy Chief of Naval Operations (Air Warfare) and Commander, Naval Air Systems Command, 1986). https://www.history.navy.mil/content/dam/nhhc/research/publications/Publication-PDF/NavalAviation1911-1986.pdf. Accessed February 7, 2017.

Oliker, Olga, and Tanya Charlick-Paley. *Assessing Russia's Decline: Trends and Implications for the United States and the U.S. Air Force* (Santa Monica: Rand Corporation, 2002). http://www.rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1442.pdf. Accessed May 21, 2017.

Oliphant, Roland. "Mapped: Just How Many Incursions into NATO Airspace Has Russian Military Made." *Daily Telegraph* (May 15, 2015). http://www.telegraph.co.uk/news/worldnews/europe/russia/11609783/Mapped-Just-how-many-incursions-into-Nato-airspace-has-Russian-military-made.html. Accessed May 21, 2017.

Perry, Dave. *A Primer on Recent Canadian Defence Budgeting Tends and Implications* (Calgary: University of Calgary School of Public Policy *SPP Research Papers*, 8 (15) (April 2015). https://www.policyschool.ca/wp-content/uploads/2016/03/canadian-defence-budgeting-perry.pdf. Accessed February 7, 2017.

Pollpeter, Kevin. "Introduction to SITC Policy Briefs." (Berkeley: University of California Institute on Global Cooperation and Conflict, 2014). https://escholarship.org/uc/item/3w58q0s2. Accessed May 21, 2017.

Poole, Walter S. *History of Acquisition in the Department of Defense: Adapting to Flexible Response, 1960–1968* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2013): 179–248. http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol2.pdf. Accessed February 9, 2017.

Providing the Means of War: Historical Perspectives on Defense Acquisition, 1945–2000. Edited by Shannon A. Brown (Washington, DC: United States Army Center for Military History and Industrial College of the Armed Forces, 2005). http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMHPub70-87-1ProvidingtheMeans.pdf. Accessed February 6, 2017.

Public Law 80-253. "National Security Act of 1947." 61 *U.S. Statutes at Large*, 502–504. http://legisworks.org/congress/80/publaw-253.pdf. Accessed December 18, 2017.

RAAF Museum. *RAAF Aircraft Photos* (Point Cook, VIC: RAAF Museum, 2015). https://www.airforce.gov.au/sites/g/files/net3736/f/minisite/static/1469/RAAFmuseum/photo_album/aircraft.htm. Accessed May 30, 2018.

Renz, Bettina. "Russian Military Capabilities After Twenty Years of Reform." *Survival*, 56 (3) (June/July 2014): 61–84. https://doi.org/10.1080/00396338.2014.920145.

Reynolds, Richard T. *Heart of the Storm: The Genesis of the Air Campaign Against Iraq* (Maxwell, AFB, AL: Air University Press, 1995). http://aupress.maxwell.af.mil/digital/pdf/book/b_0055_reynolds_heart_storm1.pdf. Accessed March 15, 2017.

Rip, Michael Russell, and James M. Hasik. *The Precision Revolution: GPS and the Future of Aerial Warfare* (Annapolis, MD: Naval Institute Press, 2002).

Royal Air Force. "Aircraft." (London: RAF, 2015). https://www.raf.mod.uk/aircraft/. Accessed May 30, 2018.

———. "Weapons." (London: RAF, 2018). https://www.raf.mod.uk/search-results/?Keywords=weapons&display=search&newSearch=true&noCache=1. Accessed May 30, 2018.

Royal Australian Air Force. *Air Force Bases* (Canberra: RAAF, n.d.): 1–2. http://www.airforce.gov.au/RAAFBases/?RAAF-EYD01E6ZiPbV0Cl+C+GKu4PSUCVwrBfQ. Accessed December 18, 2017.

———. Air Power Development Centre. *Pathfinder Bulletin*, 170 (January 2012): 1–2. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Pathfinder/PF170-Five-Generations-of-Jet-Fighter-Aircraft.pdf. Accessed December 18, 2017.

———. *Aircraft* (Canberra: Royal Australian Air Force (RAAF), 2015a). http://www.airforce.gov.au/Technology/Aircraft/?RAAF-nMfLhE/ppITHEkch5e7PfopYCzwKfhNg. Accessed May 18, 2017.

———. *History* (Canberra: RAAF, 2015b): 1–2. http://www.airforce.gov.au/History/?RAAF-Sq7iGFssX2/HNFhOlsw4TP9fITfYhI7O. Accessed February 7, 2017.

Royal Canadian Air Force. "CF-188 Hornet." (Ottawa: Royal Canadian Air Force, 2015): 1–2. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cf-188.page. Accessed May 19, 2017.

———. "Overview." (Ottawa: Royal Canadian Air Force, 2016): 1–2. http://www.rcaf-arc.forces.gc.ca/en/overview.page. Accessed December 18, 2017.

"Russian Fighter Jets Patrolling Ukraine Border." *VOA News* (February 27, 2014): 1–2. http://www.voanews.com/content/russian-fighter-jets-patrolling-ukraine-border/1860450.html. Accessed May 21, 2017.

Saunders, Philip C. *The Chinese Navy: Expanding Capabilities, Evolving Roles* (Washington, DC: National Defense University Press, 2012). http://purl.fdlp.gov/GPO/gpo19516. Accessed May 21, 2017.

Sharman, Christopher H. *China Moves Out: Stepping Stones Toward New Maritime Strategy* (Washington, DC: National Defense University Press, 2015). http://purl.fdlp.gov/GPO/gpo57396. Accessed May 21, 2017.

Shultz, Richard H. Jr. *The Future of Airpower in the Aftermath of the Gulf War* (Maxwell AFB, AL: Air University Press, 1992). http://aupress.maxwell.af.mil/digital/pdf/book/b_0048_shultz_future_of_airpower.pdf. Accessed March 15, 2017.

Spinetta, Lawrence. "The Life Cycle of Manned Aircraft." *International Journal of Defense Acquisition Management*, 6 (2014): 21–37.

Spring 2017 Industry Study: Final Report Aircraft Industry. (Washington, DC: The Dwight D. Eisenhower School for National Security and Resource Strategy, National Defense University, 2017). http://es.ndu.edu/Portals/75/Documents/industry-study/reports/2017/es-is-report-aircraft-2017.pdf. Accessed May 25, 2018.

Stephens, Alan. *Power Plus Attitude: Ideas, Strategy, and Doctrine in the Royal Australian Air Force, 1921–1991* (Canberra: Australian Government Publishing Service, 1992). http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical Publications/HIST02-Power-Plus-Attitude-Ideas,-Strategy-and-Doctrine-in-the-Royal-Australian-Air-Force,-1921-1991.pdf. Accessed May 18, 2017.

———. *Going Solo: The Royal Australian Air Force, 1946–1971* (Canberra: Australian Government Publishing Service, 1995). http://airpower.airforce.gov.au/APDC/media/PDF-Files/Historical Publications/HIST03-Going-Solo-The-Royal-Australian-Air-Force-1946-1971.pdf. Accessed February 7, 2017.

———. *The Royal Australian Air Force* (South Melbourne: Oxford University Press, 2001).

Stouffer, Ray. "Cold War Air Power Choices for the RCAF: Paul Hellyer and the Selection of the CF-5 Freedom Fighter." *Canadian Military Journal*, 7 (3) (Autumn 2006): 63–74. http://www.journal.forces.gc.ca/vo7/no3/doc/stouffer-eng.pdf. Accessed May 19, 2017.

Swanborough, Gordon, and Peter M. Bowers. *United States Military Aircraft Since 1909* (Washington, DC: Smithsonian Books, 1989).

Sweetman, Bill. "Unique J-20 Could Fit Anti-Access Role." *Aviation Week and Space Technology*, 176 (39) (November 3, 2014): 57–59.

Thetford, Owen Gordon. *Aircraft of the Royal Air Force Since 1918*. 9th ed. (London: Putnam, 1995).

"Tomcats Officially Retire." (Washington, DC: U.S. Navy, 2006): 1. http://www.navy.mil/submit/display.asp?story_id=25747. Accessed February 7, 2017.

Underwood, Jeffrey S. "Presidential Statesmen and U.S. Airpower: Personalities and Perceptions." In *The Influence of Airpower Upon History: Statesmanship, Diplomacy, and Foreign Policy Since 1903*, edited by Robin Higham and Mark Parillo, 192–193 (Lexington: University Press of Kentucky, 2013).

United Kingdom. "First World War in the Air." (London: Royal Air Force Museum, 2015). https://www.rafmuseum.org.uk/london/whats-going-on/events/opening-of-first-world-war-in-the-air-exhibition/. Accessed May 30, 2018.

United Kingdom. Ministry of Defence. *UK Armed Forces Monthly Service Personnel Statistics* (London: Ministry of Defence, 16 November 2017): 3–4. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/659404/20171001_-_SPS.pdf. Accessed December 18, 2017.

U.S. Air Force. *Air Force Fact Sheets* (Washington, DC: U.S. Air Force, 2015). http://www.af.mil/AboutUs/FactSheets.aspx. Accessed February 9, 2017.

U.S. Air Force Museum. "McDonnell F-101B Voodoo." (Dayton: National Museum of the U.S. Air Force, 2015a): 1. http://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196899/mcdonnell-f-101b-voodoo/. Accessed February 7, 2017.

———. "North American F-86 Sabre." (Dayton, OH: U.S. Air Force Museum, 2015b): 1. http://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198071/north-american-f-86h-sabre/. Accessed February 7, 2017.

U.S. Congress. House Committee on Armed Services. Subcommittee on Investigations. *Review of Arms Coproduction Agreements* (Washington, DC: GPO, 1989).

———. Senate Committee on Commerce, Science, and Transportation. Subcommittee on Aviation Operation, Safety, and Security. *The Global Competitiveness of the U.S. Aviation Industry: Addressing Issues to Maintain U.S. Leadership in the Aerospace Market* (Washington, DC: GPO, 2014). http://purl.fdlp.gov/GPO/gpo46733. Accessed March 18, 2017.

U.S. Department of State. *Foreign Relations of the United States, 1952–1954, National Security Affairs, Volume II, Part 1*. Edited by Lisle H. Rose and Neil A. Peterson (Washington, DC: GPO, 1979). http://history.state.gov/historicaldocuments/frus1952-54v02p1. Accessed February 6, 2017.

U.S. National Air and Space Intelligence Center. *People's Liberation Army Air Force* (Wright-Paterson AFB, OH: U.S. National Air and Space Intelligence Center, 2010): 11–18. http://www.au.af.mil/au/awc/awcgate/nasic/pla_af_2010.pdf. Accessed May 21, 2017.

U.S. Office of Naval Intelligence. *The People's Liberation Army Navy: A Modern Navy With Chinese Characteristics* (Suitland, MD: Office of Naval Intelligence, 2009): 5–11. http://fas.org/irp/agency/oni/pla-navy.pdf. Accessed May 21, 2017.

Velocci, Jr., Anthony L. "Further Consolidation Looms Over Industry: Many More Mergers and Acquisitions Will Occur Including One of Two 'Elephant Deals' Worldwide." *Aviation Week and Space Technology*, 152 (19) (May 8, 2000): 22–24.

Watson, Robert J. *History of the Office of the Secretary of Defense: Volume IV: Into the Missile Age, 1956–1960* (Washington, DC: Historical Office, Office of the Secretary of Defense, 1997). http://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol4.pdf. Accessed May 14, 2017.

Williams, Larry. "Estimating the Defense Spending Vote." *Electoral Studies*, 39 (September 2015): 243–255. https://doi.org/10.1016/j.electstud.2015.03.020.

Zhang, Xiaoming. *Red Wings Over the Yalu: China, the Soviet Union, and the Air War in Korea* (College Station: Texas A&M University Press, 2002).

CHAPTER 3

Emerging Military Aviation Trends and Potential US Aerospace Adversaries

The emerging international military aviation environment is part of the reason why the United States and other countries are interested in developing and deploying technologically advanced and financially expensive jet fighters. Numerous factors are prompting air forces to develop such aircraft and this chapter examines some of the factors influencing contemporary and emerging military aviation trends and developments. Particular emphasis will be placed on drones or Unmanned Aerial Vehicles (UAVs), counterterrorism purposes, the increasingly assertive nature of Chinese military policy including its Anti-Access Area Denial (A2/AD) programs, increasing Russian military airpower assertiveness, and the continuing dangers to international security interests posed by countries such as Iran and North Korea which have significant conventional militaries and nuclear weapons capabilities and aspirations.

Many of the potential military operations described in this chapter are hypothetical in nature and the exact performance of the JSF and its foreign counterparts can only be speculated on given the absence of access to classified information on fighter performance. This chapter presents scenarios in which the JSF might be used in the next two decades in a variety of operational situations and scenarios.

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_3

Counterterrorism

The United States and its allies are likely to continue using conventional airpower to conduct counterterrorism operations against state-supported terrorist groups and transnational terrorist entities such as the Islamic State (IS), human traffickers, drug dealers, and international maritime pirates. Airpower will be used for intelligence and targeting purposes and it reduces the necessity of sending in conventional or special operations forces to engage terrorist infrastructures. The United States and its allies will use the panoply of current Western airpower technological expertise including precision-guided munitions; GPS satellites; intelligence, surveillance, target acquisition, and reconnaissance (ISTAR); electronic assets; and computerized situational awareness to identify and target hostile targets. While US and allied airpower is not likely to face peer competitors with jet fighters in these theaters of operation, they may have to deal with significant anti-aircraft capabilities and the intelligence, operational, and propaganda consequences of losing fighter aircraft to shoot downs or mechanical failures such as crashes and the possibility that these aircraft and their pilots will fall into enemy hands.[1]

A limitless variety of global targets could see conventional airpower like JSF as well as existing jet fighter technologies used in counterterrorism operations. Within the Western Hemisphere, potential twenty-first-century geographic targets for US airpower include operations against Bolivarian states such as Bolivia, Cuba, Ecuador, Nicaragua, and Venezuela which support terrorist groups, drug traffickers, and human traffickers with interests antithetical to the United States.[2]

The Middle East and North Africa are likely to remain targets for the United States to use airpower against Islamist terrorist groups as varied as ISIS, Boko Haram, Al Qaida in the Islamic Maghreb and Al Qaida in the Arabian Peninsula, and other entities such as the Lord's Resistance Army.[3] South Asia, particularly regions adjacent to Pakistan and Afghanistan, is also likely to see US airpower conduct conventional operations against terrorist forces as varied as Al Qaida, the Haqqani Network, Taliban, Lashkar-e-Taiba, and others. This may involve operations in these countries as well as in surrounding Central Asian republics which may impact Chinese and Russian strategic interests. The presence of nuclear weapons in India and Pakistan will complicate the potential deployment of counterterrorism air strikes in this region.[4]

Drones/UAV

An additional factor illustrating the increasingly complex environment of contemporary and future airpower operations is the emergence of unmanned drone aircraft or UAVs. These aircraft can be remotely piloted from thousands of miles away and have been used by both the George W. Bush and Obama Administrations in anti-terrorism operations. In some cases, using these aircraft has effectively knocked out terrorist targets without inserting US or allied combat aircraft into hostile environments, resulting in financial savings. However, drone strikes have produced civilian casualties in some cases which critics charge violate international law, national sovereignty, and increase the ability of terrorists to recruit for their causes. Debate over the effectiveness and propriety of UAVs will continue for the foreseeable future. They can serve as a force multiplier for the United States and allied forces and for enemy forces. UAVs should be viewed as a supplement and not as a replacement for conventional air power. Their effects can be mitigated or countered by hostile military forces who may develop their own UAV capabilities to use against the United States and its allies and their military assets.[5]

The United States has used UAVs in military operations since World War II. Israel used these aircraft for surveillance purposes over Lebanon's Bekaa Valley in 1982. A Predator drone located Osama Bin Laden in Afghanistan in 2000 and not long after 9/11 weaponized Predator drones armed with Hellfire missiles were flying over Afghanistan. UAV use has become so prominent that contentious debate has resulted from proposals to give military awards to UAV operators for their combat mission accomplishments.[6] Data acquired from UAVs is sent to US military and intelligence agency computers and facilitates tracking and mapping enemy networks and targets and linking visual imagery with other forms of intelligence including intercepted phone calls, emails, and text messages.[7]

There were 74 US drone strikes in Afghanistan in 2007 and by 2012 US drone strikes in that country averaged 33 per month. There were five drone strikes in Pakistan in 2007 and 330 in 2012.[8] Examples of US UAV aircraft include the MQ-1 B Predator, MQ-9 Reaper, and RQ-4 Global Hawk. The Predator serves as an armed, multi-mission, medium-altitude, long-endurance remotely piloted aircraft oriented toward intelligence collecting and performing strike coordination and reconnaissance against high-value targets. It also provides intelligence, surveillance, reconnaissance, close air support, combat search and rescue, precision strike, target development, and terminal air clearance. Produced by San Diego-based General Atomics Aeronautical Systems, Predator operational capabilities are shown in Table 3.1.

The Reaper serves as an armed, multi-mission, medium-altitude, long-endurance remotely piloted aircraft used primarily for intelligence collection and secondarily against dynamic execution targets. Produced by General Atomics Aeronautical Systems, Reaper operational capabilities are shown in Table 3.2.

The Global Hawk is a high-altitude, long-endurance, remotely piloted aircraft featuring an integrated sensor suite providing global all-weather, day or night, intelligence, surveillance, and reconnaissance (ISR). It also provides persistent near-real-time coverage using imagery intelligence, signals intelligence, and moving target indicator sensors. Its prime contractor is Northrop Grumman in Rancho Granada, CA, and Bethpage, NY, with Raytheon and L3 Comm being subcontractors having locations in multiple states. Global Hawk operational capabilities are shown in Table 3.3.

Table 3.1 Predator UAV operational capabilities[9]

Power plant Rotax	*914F four-cylinder engine*
Thrust	115 horsepower
Wingspan	55 ft. (16.8 meters)
Length	27 ft. (8.22 meters)
Height	6.9 ft. (2.1 meters)
Weight	1330 lbs (512 kilograms) empty
Maximum take-off weight	2250 lbs (1020 kilograms)
Fuel capacity	665 lbs (100 gallons)
Payload	450 lbs (204 kilograms)
Speed	Cruise speed around 84 mph (70 knots), up to 135 mph
Range	Up to 770 miles (675 nautical miles)
Ceiling	Up to 25,000 ft. (7620 meters)
Armament	Two laser-guided AGM-114 Hellfire missiles
Crew (remote)	Two (pilot and sensor operator)
Unit cost	$20 million including four aircraft with sensors, ground control station and Predator Primary Satellite Link (FY 2009 dollars)
Program cost	$4.745.3 billion August 2012
Initial Operating Capability	March 2005
Inventory	Total Force, 164

Table 3.2 Reaper UAV operational capabilities[10]

Power plant	*Honeywell TPE-331-10GD Turboprop engine*
Thrust	900 shaft horsepower maximum
Wingspan	66 ft. (20.1 meters)
Length	36 ft. (11 meters)
Height	12.5 ft. (3.8 meters)
Weight	4900 lbs (2223 kilograms) empty
Maximum take-off weight	10,500 lbs (4760 kilograms)
Fuel capacity	4000 lbs (602 gallons)
Payload	3750 lbs (1701 kilograms)
Speed	Cruise speed around 230 mph (200 knots)
Range	1150 miles (1000 nautical miles)
Ceiling	Up to 50,000 ft. (15,240 meters)
Armament	Combination of AGM-114 Hellfire missiles, GBU-12 Paveway II, and GBU-38 Joint Direct Attack Munitions
Crew (remote)	Two (pilot and sensor operator)
Unit cost	$56.5 million includes four aircraft with sensors, ground control station, and Predatory Primary satellite link (FY 2011 dollars)
Program cost	$33.637 billion August 2012
Initial Operating Capability	October 2007
Inventory	Total Force 104

Table 3.3 Global Hawk operational capabilities[11]

Power plant	*Rolls-Royce North American F-137-RR-100 turbofan engine*
Thrust	7600 lbs
Wingspan	130.9 ft. (39.8 meters)
Height	15.3 ft. (4.7 meters)
Weight	14,950 lbs (6781 kilograms)
Maximum take-off weight	32,250 lbs (14,628 kilograms)
Fuel capacity	17,300 lbs (7847 kilograms)
Payload	3000 lbs (1360 kilograms)
Speed	357 mph (310 knots)
Range	12,300 nautical miles
Endurance	More than 34 hours
Ceiling	60,000 ft. (18,288 meters)
Armament	None
Crew (remote)	Three (LRE pilot, MCE pilot, and sensor operator)
Unit cost	$222.69 million August 2012
Program cost	$893.8 million FY 2014
Initial Operating Capability	2011 (Block 30); 2015 (Block 40)
Inventory	Active Force, 33 (three more Block 30s purchase, to be fielded in 2017)

China

The most challenging and threatening security environment for the United States and its allies remains the growth of China and Beijing's increasingly assertive diplomatic, economic, and military claims in the Asia-Pacific region. During May 2009 Beijing submitted to the United Nations Convention on the Law of the Sea (UNCLOS) a nine-dashed map claiming indisputable sovereignty over the entire body of water, islands, seabed, and subsoil within the 200-mile nautical limit of the Outer Continental Shelf of the South China Sea.[12]

On November 23, 2013, China established an Air Defense Identification Zone (ADIZ) over the East China Sea featuring some overlap with existing Japanese and South Korean ADIZs. This edict saw Beijing set rules requiring aircraft flying in this area to:

- Report a flight plan to the Chinese Government;
- Maintain radio communication and respond to Chinese government identification inquiries;
- Maintain radar transponder function; and
- Exhibit clear nationality and logo markings.

This announcement also stated China's military would take emergency defensive measures to respond to aircraft not giving required identification.[13]

China's military has engaged in aggressive behavior against the United States and allied countries' military and civilian aircraft for over a decade. Examples of this behavior includes a United States Navy (USN) electronic surveillance plane being struck by a Chinese fighter pilot on March 31, 2001, forcing the US aircraft to make an emergency landing on Hainan Island; five Chinese naval vessels attempting to snag the *USNS Impeccable's* towing cable 75 miles southeast of Hainan Island on March 5, 2009, forcing the Navy to dispatch warships to escort unarmed survey and ocean surveillance vessels; two Chinese naval vessels approaching the *USS Cowpens*, crossing directly in front of this vessel, and forcing it to stop to avoid a collision on December 5, 2013, about 32 miles southeast of Hainan Island; and an armed Chinese jet fighter conducting a dangerous intercept of a Navy P-8 Poseidon aircraft on August 19, 2014, in international airspace 135 miles east of Hainan Island. Japanese Air Self Defense Force aircraft scrambled against Chinese aircraft 199 times between April and June 2016 in the air and water over the disputed Senkaku/Diaoyu Islands.[14]

Recent analysis of China's PLAAF indicates a force that is benefiting from increasing military spending and demonstrating a commitment to enhancing Beijing's ability to project power into the Western Pacific and surrounding oceans to deter US and allied strategic interests. A critical emphasis of Chinese airpower planning is regaining control of Taiwan.[15]

The 2015 edition of the Defense Department's annual report on Chinese military power notes that the Chinese Navy has more than 300 surface vessels, the largest in Asia, and is emphasizing new anti-ship, anti-air, and anti-submarine weapons and sensors. It also notes that Beijing's PLAN is moving from "near seas" to "far seas" operations capable of power projection beyond immediate territorial waters in the East and South China Seas. PLAN's aircraft carrier *Liaoning* was expected to have an air wing in 2015 or later with additional aircraft carriers possible.[16]

This document also reports that PLAAF is Asia's largest and third largest in the world, possessing over 2800 aircraft (not including unmanned aircraft) and 2100 combat aircraft including fighters, bombers, fighter-attack, and attack aircraft. DOD asserts that PLAAF is rapidly closing the gap with Western air forces across a broad spectrum of aircraft capabilities including aircraft, command and control, jammers, electronic warfare, and data links. The majority of Beijing's air forces are expected to be fourth generation in the next few years.[17]

The indigenously developed J-10B is a fourth-generation fighter expected to enter service and China is likely to acquire Russia's Su-35 Flanker aircraft with its advanced IRBIS-E passive electronically scanned array radar system. The Su-35 could enter the PLAAF by 2018, and in October 2014 Russian Deputy Prime Minister Dmitry Rogozin said Moscow would like to export 24 Su-35S fighters to China. Beijing has been pursuing fifth-generation fighters since 2009 and is the only country besides the United States with two concurrent stealth fighter programs. PLAAF observations of foreign military employment of stealth aircraft are viewed as a critical capability in transforming from a territorial air force to a force capable of conducting offensive and defensive operations. Beijing believes stealth aircraft provide an offensive operational advantage denying adversaries time to mobilize and conduct defensive operations consistent with China's emphasis on A2/AD operations against opposing forces.[18]

Third- and fourth-generation J-20 stealth prototypes conducted first flights in March and July 2014 and test flights with a fifth-generation prototype may occur by the end of 2015. October 31, 2012, saw the first flight of China's J-31 fighter which the Pentagon believes is similar in size to the JSF and the J-31's design characteristics appear to be similar to the J-20s. In addition, Beijing also has one of the globe's largest forces of advanced long-range SAM systems consisting of a combination of Russian SA-20 (S-300PMU1/2) battalions and domestically produced CSA-9 (HQ-9) battalions. Beijing plans further enhancements to its strategic air defense systems by importing Russia's S-400/Triumf SAM system while possibly simultaneously developing its indigenous CSA-X-19 (HQ-19) for a foundational ballistic missile defense capability.[19]

US and allied JSF fighters might be used in the event of a Chinese invasion of Taiwan. DOD's 2015 report on Chinese military power provides the quantification in Table 3.4 on the current airpower cross-straits balance between Beijing and Taipei:

While these figures do not include Chinese missile or amphibious lift capability, nor do they demonstrate whether the United States and other countries would be willing to come to Taiwan's defense, they illustrate the significant initial airpower advantage Beijing would hold in a conflict in the East Asian/Western Pacific theater of operations.

China is also making extensive efforts to develop its UAV military programs. Organizations such as Chengdu Aircraft Industry Group/Chengdu Aircraft Design Institute, Guizhou Aircraft Industry Corporation, Shenyang Aircraft Company/Shenyang Aircraft Design Institute, China Aerospace Science and Technology Corporation, China Aerospace Science and Industry Corporation, and Nanjing Research Institute on Simulation Technique have developed fixed and rotary wing UAVs, precision-guided munitions, AGMs, battlefield reconnaissance, enemy air defense suppression capabilities, and specific weapons such as the Xianglong/Soar Dragon, a high-altitude, long-endurance UAV resembling the US RQ-4. A 2012 US Defense Science Board study contended that Chinese UAV capabilities could "easily match or outpace U.S. spending on unmanned systems, rapidly close the technology gaps, and become a formidable competitor in

Table 3.4 2015 China aircraft within range of Taiwan[20]

China		*Taiwan*	
Aircraft	*Total*	*Within range of Taiwan*	*Total*
Fighters	1700	130	388
Bombers/Attack	400	200	22
Transport	475	150	21

unmanned systems." Beijing is also seeking to harness its military innovation capabilities to make it one of the world's leading military technological powers by 2020.[21]

A possible US response to China's increasing military power is found in the Air-Sea Battle (ASB) concept. ASB is not a military doctrine or strategy, but seeks to ensure global commons freedom of action to reassure allies and deter potential adversaries. ASB seeks to counter and asymmetrically and symmetrically shape A2/AD environments, and developing integrated forces capable of succeeding in such environments. ASB seeks to respond to A2/AD by developing networked integrated forces capable of attacking in depth to disrupt, defeat, and destroy enemy forces; using air, cyber, land, maritime, and space assets in this regard for friendly joint and coalition forces; providing commanders with ready access to capabilities across these domains regardless of which commander owns them; integrating these forces before entering operational theaters, and attacking in depth to disrupt, defeat, and destroy enemy A2/AD platforms.[22] ASB has not been formally incorporated into US military strategic or doctrinal planning and has not had money appropriated for its implementation. It has received mixed assessments in strategic studies literature, but it can be viewed as a potential template for potential US and allied military operations against China that may involve using the JSF as an offensive and defensive platform.[23]

ASB had evolved into Joint Concept for Access and Maneuver in the Global Commons (JAM-GC) as of early 2015.[24]

Chinese military targets for US and allied aircraft are widespread. They would include military command and control targets in Beijing and elsewhere. Depending on the nature of a military conflict with China, target lists could include targets over wide geographic ranges from Central Asia to the Pacific and from the Russian frontier to strategically important Hainan Island. PLA groups which could be targeted by the JSF and other weapons systems include the 27th, 38th, and 65th group armies in the Beijing military region; the 13th and 14th group armies in the Chengdu military region; the 15th airborne rapid reaction unit, and the 41st and 42nd group armies in the Guangzhou military region; the 20th, 26th, and 54th group armies in the Jinan military region; the 21st and 47th group armies in the Lanzhou military region; the 1st, 12th, and 31st group armies in the Nanjing military region; and the 16th, 39th, and 40th group armies in the Shenyang military region.[25]

Figure 3.1 lists various Chinese air and naval assets that could be targeted in a military conflict including the East, North, and South Sea fleets.[26]

A Chinese invasion of Taiwan would place Beijing's military assets in Nanjing province at risk of attack including its extensive missile assets and air power capabilities as demonstrated on maps in DOD's 2015 annual

Fig. 3.1 China air and naval assets by region. Source: U.S. Department of Defense 2015

report on Chinese military power.[27] Oil and natural gas transit choke points could also be targeted by China's opponents in a military confrontation in areas as geographically dispersed as Kazakhstan, Russia, and Burma.[28]

However, any military response against China by the United States and its allies, regardless of whether this response includes a mixture of air, cyber, land, sea, and space strikes, must also account for the regional and global strategic strike capabilities of Chinese conventional and nuclear missiles and the amount of time and geographic distance required for US ships to reach the South China Sea from the United States and other locations demonstrated by the following four maps which will affect the impact and effectiveness of any military strikes against Beijing and how China might target its military opponents (Fig. 3.2).[29]

Fig. 3.2 China conventional strike capabilities or maximum missile range. Source: U.S. Department of Defense 2016

Iran

Another potential theater of operations for US military aircraft such as the JSF is Iran. Tehran's widespread support for international terrorism and its nascent nuclear weapons program are of acute concern to countries as diverse as the United States, Israel, European Union countries, and Persian Gulf states such as Saudi Arabia. Numerous scenarios could involve military strikes against Iranian military targets with ones against Iranian nuclear sites such as Arak, Esfahan, Fordow, Lavizan-Shian, Natanz, Parchand, and Tehran. Such strikes would need to be sustained to be effective and could result in Iranian military retaliation through conventional means, terrorism, cyberwar, and other means.[30]

Iran has acquired long-range missiles from North Korea and developed indigenous liquid and solid-fueled missiles giving it a strike capacity and has some chemical weapons and a potential biological weapons capability. The overall size of its armed forces is estimated at 500,000–525,000, including Revolutionary Guards, though many of its forces are poorly trained conscripts. Tehran's Air Force personnel are estimated at 25,000–35,000 and its regular naval personnel are estimated at 18,000. The International Institute of Strategic Studies (IISS) believes Iran has a combat aircraft inventory of 312 with 40–60% of these having limited or zero mission capability. Age and obsolescence are also major problems for Tehran's Air Force with 60% of these planes being purchased by the Shah's government in the 1970s and including F-14s, F-5B, and various F-4s which have not been modernized. It also has Russian MiG-29 and Su-24K, French F-1E Mirages, and Chinese F-7ms in its arsenal. Tehran has tried to produce light Saegheh and Azarakhsh fighters into its arsenal but these are far behind the United States, Saudi, and United Arab Emirates' fighter purchases and Tehran's purchases are drastically restricted by UN sanctions.[31]

Iran has land-based SAMs from Chinese, Russian, and US sources. However these are obsolete and highly vulnerable to electronic countermeasures and anti-radiation missiles. Tehran's air defense system is vulnerable to stealth strike fighters, cruise missiles, and ASMs fired from outside its SAM coverage. Acquiring advanced SAM systems with antiballistic missile capabilities such as Russia's S300 and advanced radars and command and control systems necessary to integrate them into a more effective system would be Tehran's aspirational goal. While Iran could not win any serious military confrontation with the United States or its allies, it can threaten, intimidate, and execute significant low level or terrorist attacks directly or through surrogates against regional and major powers.[32]

Iranian nuclear sites are featured in Fig. 3.3.

Potential US or other country military strikes against Iran must factor in Iranian ballistic missile ranges and accuracy as well as the range of Tehran's military aircraft. Medium-range ballistic missiles (MRBMs) and their ranges include the Ghadr-110 (1240–1800 miles/2000–3000 kilometers); Shabab-3 (1302 miles/2100 kilometers); Ashoura (1240–1553 miles/2000–2500 km); and Sejjil (1240–1553 miles/2000–2500 kilometers). Intermediate range ballistic missiles (IRBMs) available to Tehran, despite concerns about their guidance and accuracy, include the Shabab-5 (1864–3106 miles/3000–5000 kilometers) and Shabab-6 (1864–3106 miles/3000–5000 kilometers).[33]

Fig. 3.3 Known Iranian nuclear sites. Source: Hassan, Congressional Research Service

North Korea

The Korean peninsula has remained one of the world's most dangerous security arenas since the Korean War's conclusion in 1953. The United States retains close political and military ties with South Korea and North Korea's totalitarian regime maintains a large military capacity and force structure, possesses a nuclear weapons arsenal, and periodically engages in aggression against South Korea as demonstrated by a March 26, 2010, torpedo attack against the naval vessel *Cheonan* near Baengnyeong Island in the Yellow Sea killing 46 sailors, a November 23, 2010, North Korean artillery attack against Great Yeonpyeong in the Yellow Sea killing two South Korean marines and six civilians while destroying 70 houses, resulting in South Korea returning fire and causing an unknown number of North Korean casualties, and North Korea firing anti-aircraft round at South Korean propaganda balloons launched from Paju, South Korea, on October 10, 2014, with the South Korean military returning fire.[34]

Any aerial confrontation with North Korea involving the JSF and other aircraft would inevitably target Pyongyang's ballistic missile arsenal which can carry nuclear weapons. According to the US National Air and Space Intelligence Center (NASIC), North Korean short-range ballistic missile (SRBM) capabilities are believed to be as shown in Table 3.5.

North Korean IR/MRBM capabilities are believed to be as shown in Table 3.6.

North Korean intercontinental ballistic missile (ICBM) assets are assessed by NASIC as shown in Table 3.7.

Despite its poverty-stricken nature exacerbated by autocratic government policies, North Korea has amassed one of the world's largest militaries. Its ground forces are estimated to number 950,000 and are concentrated in areas close to the South Korean border.[38]

Pyongyang's Air Force order of battle numbers 110,000 personnel, over 800 combat aircraft, 300 helicopters, and over 300 transport aircraft as Fig. 3.4 illustrates.[39]

Table 3.5 North Korean short-range ballistic missile (SRBM) capabilities[35]

Missile	*Propellant*	*Deployment mode*	*Maximum range*	*Launcher numbers*
SCUD B	Liquid	Road-Mobile	186 miles/300 km	Fewer than 100
SCUD C	Liquid	Road-Mobile	310 miles/500 km	Fewer than 100

Table 3.6 North Korean intermediate/medium-range ballistic missile (IR/MRBM) capabilities[36]

Missile	*Number of stages*	*Propellant*	*Deployment mode*	*Maximum range*	*Launcher numbers*
Bukkeukseong-2 (MRBM)	2	Solid	Road-Mobile	620+ miles/1000+ km	Not yet deployed
ER SCUD (MRBM)	1	Liquid	Road-Mobile	620 miles/1000 km	Undetermined
No Dong 1/2 (MRBM)	1	Liquid	Road-Mobile	740+ miles/1200+ km	Fewer than 100
Hwasong 12 (IRBM)	1	Liquid	Road-Mobile	1860 +miles/3000+ km	Undetermined
Hwasong 10 (Musudan) (IRBM)	1	Liquid	Road-Mobile	1860+ miles/3000+ km	Fewer than 50

Table 3.7 North Korean intercontinental ballistic missile (ICBM) capabilities[37]

Missile	*Number of stages*	*Warheads per missile*	*Propellant*	*Deployment mode*	*Maximum range*	*Number of launchers*
Taepo Dong 2	3	1	Liquid	Fixed	7400+ miles/12,000+ km	Undetermined
Hwasong-13	3	1	Liquid	Road-Mobile	3510+ miles/5500+ km	Undetermined
Hwasong-14	2	Unknown	Liquid	Road-Mobile	3510+ miles/5500+ km	Undetermined

Fig. 3.4 North Korean air forces. Source: U.S. Department of Defense, "Military and Security Developments," 2015

The order of battle for North Korean naval forces numbers approximately 60,000 personnel, 260 amphibious landing craft, and 30 mine warfare vessels as illustrated in DOD's biennial North Korean military power report.[40]

North Korea's military is primarily ground centric, so military strikes against it would initially be targeted toward the 70% of ground forces and 50% of air and naval forces deployed within 62 miles/100 kilometers of the Demilitarized Zone (DMZ). These ground forces are characterized by regular and light infantry units supported by armored and mechanized units and heavy artillery concentrations. They are also fortified in several thousand underground facilities and have long-range artillery capable of firing from the DMZ to Seoul. The Air Force is responsible for inserting special operations forces and its most capable combat aircraft are Russian MiG-23 and MiG-29 fighters and Su-25 ground attack aircraft. The preponderance of Pyongyang's Air Force consists of older MiG aircraft. The North Korean Air Force has a thick and overlapping air defense system of SA-2, SA-3, and SA-5 SAM sites, mobile SA-13 SAMs, mobile and fixed anti-aircraft artillery, and numerous man-portable air defense systems like the SA-7. The Navy is divided into East and West coast fleets consisting primarily of aging vessels. Although Pyongyang's conventional forces have not kept up with emerging military technology due to international economic sanctions, these forces remain capable of inflicting significant casualties on any enemies and their equipment.[41]

Despite the obsolescence of much of its conventional forces, North Korea remains dangerous due to the military's absolute control of North Korean policymaking. Pyongyang's nuclear weapons arsenal, aided by cooperation with Iran and Syria, is likely to be used, along with the regime's determination to maintain power at all costs. A military confrontation with North Korea would also have to target Pyongyang's nuclear sites such as Unggi and Yongbyon.[42]

Russia

The Russian Federation's increasing international assertiveness is demonstrated by its 2014 annexation of Crimea, Moscow's ongoing support for separatists in Ukraine, and its Air Force incursions into the airspace of countries as diverse as Japan, the United States, and the United Kingdom documented in numerous sources. Moscow's increasing military cooperation with Beijing including conducting joint exercises with China and its increasing defense expenditures under President Vladimir Putin have resurrected a Cold War geopolitical security environment, and may make it necessary for Western powers and the US Asia-Pacific allies to conduct aerial military operations against Russia using weapons systems such as the JSF in the foreseeable future.[43]

Potential US/NATO operations against Russia involving use of the JSF and other jet fighters and aerial assets such as UAVs would have a large range of targets to strike. These would include Russia's energy infrastructure including oil and natural gas pipelines stretching from delivery markets in Western Europe to the Arctic, Barents, Black, and Caspian Seas (Fig. 3.5).[44]

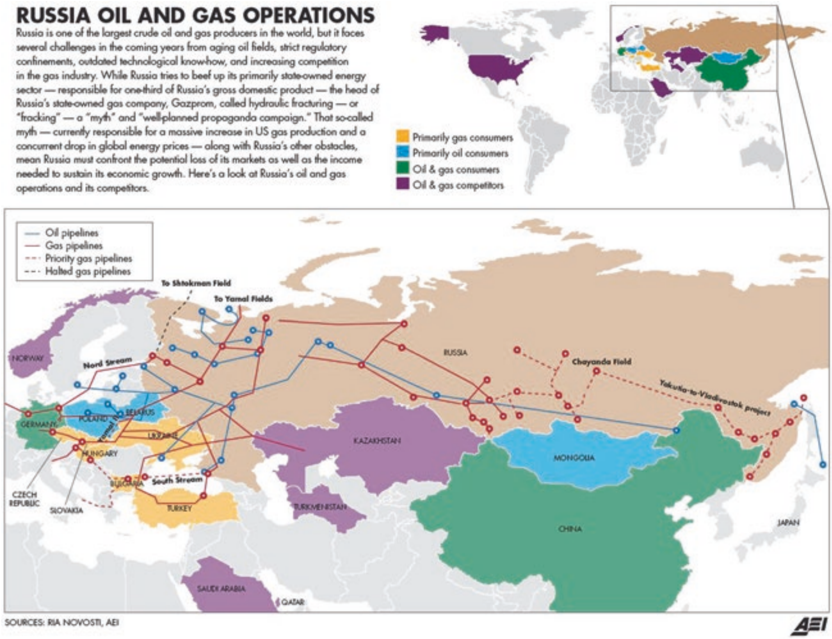

Fig. 3.5 Russia oil and gas operations. Source: Davies and Mugg, American Enterprise Institute

Russia's military, although suffering from a reduced demographic base and corruption, still strives to dominate the periphery of nations surrounding the Russian Federation's extensive territories. It also seeks to expand security ties and influence with Collective Security Treaty Organization (CSTO) countries, many of which were once part of the Soviet Union, and to recover territory lost with the Soviet Union's collapse. A 2014 analysis maintained that Moscow will spend over $730 billion over the next decade to modernize the Russian military with approximately $650 billion of this spent on new equipment. These new purchases are expected to include 100 naval vessels, 600 warplanes, and 1000 helicopters by 2020.[45]

Nuclear weapons continue playing a critical role in Russian military doctrine and strategy. Moscow has reported 1400 warheads on 473 deployed strategic launchers and over 2300 strategic weapons on non-deployed strategic launchers along with 4000 non-nuclear strategic weapons. This arsenal includes bombs and warheads for the SS-21 Tochka and SS-26 Iskander SRBM, and warheads for A-135 and S-300 ABMs. Moscow's Strategic Rocket Forces have an 18 launcher division of Yars SS-29 ICBMs designed to penetrate US ballistic missile defenses and Putin plans to add 400 new ICBMs and submarine-launched ballistic missiles (SLBMs) during the next decade to Russian nuclear forces.[46]

Russian SRBM ballistic missile capabilities are shown in Table 3.8.

Russian ICBM capabilities, according to the NASIC, are shown in Table 3.9.

Russian nuclear missile facilities and airbases would be subject to attack by the JSF or other US/NATO military assets in a potential war and are located in multiple time zones and regions as Figs. 3.6 and 3.7 indicate.

Table 3.8 Russian SRBM capabilities[47]

Missile	*Propellant*	*Deployment mode*	*Maximum range*	*Launchers*
SCUD B (SS-1)	Liquid	Road-Mobile	186 miles/300 km	Fewer than 200
SS-1C (Mod 2)	Liquid	Road-Mobile	148 miles/240+ km	Fewer than 200
SS-21 (Mod 2)	Solid	Road-Mobile	43 miles/70 km	Fewer than 200
SS-21 (Mod 3)	Solid	Road-Mobile	74 miles/120 km	Fewer than 200
SS-26	Solid	Road-Mobile	186 miles/300 km	Fewer than 200
Iskander-E	Solid	Road-Mobile	174 miles/280 km	Fewer than 200

Table 3.9 Russian ICBM capabilities[48]

Number of stages	*Warheads per missile*	*Propellant*	*Deployment mode*	*Maximum range*	*Number of launchers*
2+Post-Boost Vehicles (PBV)	10	Liquid	Silo	6200 miles/10,000+ km	About 50
2+PBV	6	Liquid	Silo	5592 miles/9000+ km	About 50
3+PBV	1	Solid	Road-Mobile	6835 miles/11,000 km	150+
3+PBV	1	Solid	Silo & Road-Mobile	6835 miles/11,000 km	About 80
3+PBV	Multiple	Solid	Silo & Road-Mobile	6835 miles/11,000 km	About 20
SS-X-28	At least 2	Solid	Road-Mobile	3417 miles/5500+ mm	Not yet deployed

Fig. 3.6 Russian strategic rocket forces. Source: Defense Intelligence Agency

Fig. 3.7 Russian air forces air bases. Source: Defense Intelligence Agency. Note: Moscow maintains aviation units in Armenia and Kyrgyzstan, represented on the map by the two fighter base symbols outside Russia's borders

Russian naval and air bases in Crimea could be targeted by Western forces, Russian naval bases in Syria could be targeted by Israel, and the growth of Russia's Northern Fleet is also likely to make it a target for US/NATO attacks.

Russia is seeking to augment its UAV arsenal which remains significantly behind Western capabilities. A January 2015 analysis by the US Army's Foreign Military Studies Office (FMSO) contends Moscow's UAVs are unarmed and primarily used for artillery spotting, reconnaissance, and signal retransmission with particular emphasis on its economically and strategically critical energy sector. This same assessment predicted Russian robotic military capacity would achieve progress in subsequent years in conducting reconnaissance and detecting and destroying fixed and mobile targets.[49]

During 2014, Russia added almost 200 UAVs to its inventory while activating 14 companies with an emphasis on supporting Russian motorized rifle brigades and implementing a dedicated UAV company in the next few years. While the Russian Ministry of Defense plans its first UAV regiment, FMSO estimates Moscow would need to spend $9.2 billion in the necessary technology if it aspires to catch up with Western UAV capabilities. Currently, the Defense Ministry's Unmanned Aviation Center in suburban Moscow's Kolomna is the only institution training specialists to work with UAVs and testing advanced vehicles with a workforce numbering around 100.[50]

An April 22, 2015, Voice of America (VOA) report noted UAV capabilities had been incorporated into Eastern Ukraine air defense efforts as part of Moscow's support for pro-Russian separatists in that country and FMSO also noted that during 2015 Moscow will establish an UAV regiment in Crimea as part of the Black Sea Fleet's naval aviation force to monitor and track NATO ships in the Black Sea. The United States and its allies have also deployed UAV assets to this region to gather intelligence on Russian activities.[51]

In a military confrontation with Russia, the United States and its NATO allies are likely to deploy the JSF, F-22, Typhoon, and other jet fighters against Russian jet fighters such as the SU-35 and T-50 (PAK-FA) on fronts whose geographic coverage is likely to extend from the Arctic to the Baltic Republics, Eastern Europe, Black Sea region, and potentially other theaters of operation. Considerable debate exists within the military and among civilian analysts as to how US/NATO aircraft would fare in operations against these Russian aircraft. The Russian T-50 is Moscow's first combat aircraft made from a high proportion of composite materials representing 25% of the aircraft's mass and 70% of its surface. The visibility of US F-22 is 0.3–0.4 square meters but the T-50's visibility is between 0.1 and 1.0 meters. Former US Air Force Chief of Intelligence Lt. General David Deptula has said the T-50's design is at least equal and potentially superior to US fifth-generation aircraft while also commenting: "It certainly has greater agility with its combination of thrust vectoring, all moving tail surfaces, and excellent aerodynamic design, than does the F-35."[52]

US Air Force Chief of Staff General Mark Welsh III has noted that severe defense budget cuts will have an adverse impact on US air superiority. During May 2015, Welsh mentioned that in three to five years China and Russia could be fielding capabilities superior to those of the United States in many areas, noting that the technological gap between the United States and these countries has closed. Welsh also contended that in eight to ten years the United States could be facing countries using top-end Chinese and Russian fighters whose fighter jet technology innovations are at least somewhat derived from stolen US intelligence while also noting that the US Air Force's active component is 40% (200,000 personnel) smaller than the first Persian Gulf War in 1990–1991.[53]

While the precise technical capabilities of Russian aircraft such as the Su-35 and T-50 remain classified and have not been subject to operational combat action, they need to be taken seriously by the United States and its NATO allies given Russia's commitment to increasing its defense capabilities and its aggressive air power actions against Western countries in recent years. Increasing Russian public willingness to support increased military spending is reflected by a July 2015 poll in which 53% of respondents said Russian military spending should be increased even if it retards economic development and another poll that month saw 86% of Russians say their military should be capable of defending the country from external military threats.[54]

Conclusion

Developing and advancing military jet fighter technology is a never-ending process. Despite the financial costs involved, many countries, particularly China and Russia, have proven willing to make the financial investments to develop jet fighters to further their national strategic interests and objectives and challenge the national and strategic interests of the United States and its allies. Besides aforementioned Russian support for increasing military spending, Beijing's *Made in China 2025* initiative which strives to increase Chinese autarky in military aircraft, computer chips, and robotics is a critical indicator of China's determination to militarily challenge the United States.[55]

Despite economic problems facing the United States and its allies, including growing budget deficits, increased national debt, and public ambivalence toward increased military spending reflected in a February 2015 Gallup poll showing 32% thought too much was being spent on defense, 29% feeling defense spending was just right, and 34% feeling too little was spent on defense. A September 2017 Politico and Harvard School of Public Health poll found increasing defense spending was an extremely important priority for 17%, a very important priority for 25%; a only somewhat important priority for 13%, and should not be a priority for 42%. A November 2017 Henry J. Kaiser Family Foundation survey found that 36% favored increased defense spending if the Republican tax plan included individual and corporate tax cuts while 62% opposed increasing defense spending with these provisions.[56]

A 2017 Heritage Foundation analysis of US national security capabilities expressed concern about the effectiveness of US military aviation and Washington's aging US military aviation fleet. It also sought to make US policymakers and public opinion aware of the increasing age of the US jet fighter fleet. Its overall assessment of US military capability was presented on a scale ranging from very weak, weak, marginal, strong, and very strong was marginal. China and Russia were rated as high threats to vital US interests, with Iran and North Korea rated as elevated threats. All of these countries, along with Afghanistan/Pakistan, and Middle East terrorism were related as aggressive threats to vital US interests on a scale whose threat levels range from benign, assertive, testing, aggressive, and hostile. The capability of these countries' threats on a scale ranging from marginal, aspirational, capable, gathering, and formidable was aspirational for Iran, capable for North Korea, and gathering for China and Russia.[57]

The Navy's air wing capacity was rated as a 3 on a five-point scale, with 1 being the lowest and 5 being the highest. Overall US military power, on a scale ranging from very weak, weak, marginal, strong, and very strong, was rated marginal for capacity, weak for capability, and strong for readiness for a cumulative overall marginal rating.[58]

The Air Force's overall military capability was strong while Heritage noted its aging aircraft and troubled modernization programs such as the JSF.

Heritage rates the Air Force's capacity score as strong, its capability as marginal, and readiness as marginal. It noted that the Air Force operated with a 2016 capability of 1159 fighter aircraft which is 96.58% of the 1200 aircraft fleet required for two major regional conflict (MRC) operations. Heritage went on to observe that Air Force readiness has been degraded due to an accumulating shortage of pilots and maintainers and 2013 budget sequestration.[59]

Particular concern is reflected with the continually increasing age of US jet fighter platforms. The Navy's F/A-18 A/D Hornet whose fleet inventory is 328 and was first deployed in 1983 has a fleet age of 24.5 years, and the F/A-18 E/F Super Hornet with an inventory of 550 was first deployed in 2001 and has a fleet age of 13.4 years. Heritage gives the overall capability score of these aircraft as a 3 on a scale from 1 to 5, with 1 being the oldest and 5 being the newest. Aging and obsolescence concerns also apply to Air Force fighter and ground attack aircraft. The A-10 Thunderbolt, whose inventory is 143, was first deployed in 1977, and its fleet age is 33 years with an age score of 2 and capability score of 1 on a five-point scale. The 317-strong F-15 fleet was first deployed in 1979, its fleet age is 27.7 years, its age score is 2, and capability score is 2. The 570-strong F-16 fleet was first deployed in 1978, its fleet age is 24.9 years, age score is 1, and capability score is 1. Finally, the F-22 fleet inventory is 165 strong, it was first deployed in 2005, its fleet age is 7.9 years, and its age score is 5.[60]

The Marine Corps military capacity was rated as weak while its capability and readiness were rated as marginal, giving it an overall marginal military power rating. The Marine Corps EA-6B electronic warfare fleet of 18 was first deployed in 1971, has a fleet age of 27, and an age score of 1. Their AV-8B Harrier fleet of 131 was first deployed in 1985, has fleet age of 18, and an age score of 1.[61]

All of these factors help contribute to the desire of the United States and allied countries to develop a jet fighter program capable of meeting their military requirements for the second decade of the twenty-first century and beyond given threats emerging from China, Iran, North Korea, and Russia along with transnational threats such as terrorism. The JSF has been chosen by the United States and many of its allies as the fighter platform best suited to meet these emerging military aviation requirements. JSF's successes, failures, and controversies are chronicled in subsequent chapters.

Notes

1. See Stephen Sloan, *International Terrorism: An Action Strategy for Preemption and* Punishment, rev. ed. (Maxwell AFB, AL: Air University Press, 2000); http://purl.access.gpo.gov/GPO/LPS20458; Accessed June 16, 2017; *Combatting Terrorism: Strategies of Ten Countries*, Yonah Alexander, ed., (Ann Arbor: University of Michigan Press, 2002); James S. Corum and Wray R. Johnson, *Airpower in Small Wars: Fighting Insurgents and Terrorists*, (Lawrence: University Press of Kansas, 2003); Qaa'id K.M. Al-Khuzaa'I, "The Use of Airpower in Combatting Terrorism in Iraq," *Air and Space Power Journal*, 32 (1)(Spring 2009): 11–18; http://www.airpower.au.af.mil/airchronicles/apj/apj09/spr09/alkhuzaai.html; Accessed June 16, 2017; and *Airpower in Afghanistan 2005–2010: The Air Commanders' Perspectives*, Dag Henriksen, ed., (Maxwell AFB, AL: Air University Press, 2014); http://www.au.af.mil/au/aupress/digital/pdf/book/b_0000_henriksen_commanders_perspectives.pdf; Accessed June 16, 2017.
2. See U.S. Department of State, *International Narcotics Control Strategy Report 2014*, (Washington, DC: Department of State, 2014): http://www.state.gov/j/inl/rls/nrcrpt/2014/; Accessed June 16, 2017; U.S. Department of State, Counterterrorism Bureau, *Country Reports on Terrorism 2014*, (Washington, DC: Department of State, 2015): http://www.state.gov/documents/organization/239631.pdf; Accessed June 23, 2017; and U.S. Department of State, *Trafficking in Persons Report 2014*, (Washington, DC: U.S. Department of State, 2014): http://www.state.gov/j/tip/rls/tiprpt/2014/; Accessed June 16, 2017.
3. See Colin S. Gray, *Air Power for Strategic Effect*, (Maxwell AFB, AL: Air University Press, 2012); http://purl.fdlp.gov/GPO/GPO56522; Accessed June 16, 2017; Ross Harrison, "Confronting the 'Islamic State': Towards a Regional Strategy Contra ISIS," *Parameters*, 44 (3)(Autumn 2014): 39–46; and Michael M. Gunter, "Iraq, Syria, ISIS, and the Kurds: Geostrategic Concerns for the U.S. and Turkey," *Middle East Policy*, 22 (1) (Spring 2015): 102–111.
4. See Sumit Ganguly, "Nuclear Stability in South Asia," *International Security*, 33 (2)(Fall 2008): 45–70; Kevin A. O'Brian, "Assessing Hostile Reconnaissance and Terrorist Intelligence Activities," *RUSI Journal*, 153 (3)(October 2008): 134–139; David E. Thaler, Theodore W. Kerasik, et al., *Future U.S. Security Relationships with Iraq and Afghanistan: U.S. Air Force Roles*, (Santa Monica: Rand Corporation, 2008): http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG681.pdf; Accessed June 16, 2017; and Dhiraj Kukreja, "Air Power: Future Challenges and Emerging Roles," *Air Power Journal*, 9 (3)(July–September 2014): 55–78; http://capsindia.org/files/documents/APJ-Jul-Sep-2014-inside.pdf; Accessed June 16, 2017.

5. Examples of the proliferating literature on drone aircraft includes Jordan J. Paust, "Self-Defense Targetings of Non-State Actors and Permissibility of U.S. Use of Drones in Pakistan," *Journal of Transnational Law and Policy*, 19 (2)(2010): 237–280; Tyler Wall and Torin Monahan, "Surveillance and Violence from Afar: The Politics of Drones and Liminal Security-Scapes," *Theoretical Criminology*, 15 (3)(2011): 239–254; https://doi.org/10.1177/1362480610396650; *The American Way of Bombing: Changing Ethical and Legal Norms from Flying Fortresses to Drones*, Matthew Evangelista and Henry Shue, eds., (Ithaca: Cornell University Press, 2014); *Drone Wars: Transforming Conflict, Law, and Policy*, Peter L. Bergen and Daniel Rothenberg, eds., (New York: Cambridge University Press, 2014); and Michael J. Boyle, "The Race for Drones," *Orbis*, 59 (1)(Winter 2015): 76–94; https://doi.org/10.1016/j.orbis.2014.11.007.
6. See Houston R. Cantwell, "Operators of Air Force Unmanned Systems: Breaking Paradigms," *Air & Space Power Journal*, 23 (Summer 2009): 67–77; Dave Blair, "Ten Thousand Feet and Ten Thousand Miles: Reconciling our Air Force Culture to Remotely Piloted Aircraft and the New Nature of Aerial Combat," *Air & Space Power Journal*, 26 (3)(May–June 2012): 61–69; http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2012-May-Jun/V-Blair.pdf; Accessed June 16, 2017; and "Medals for Drone Pilots," *The Economist*, 410 (8880) (March 29, 2014): 33.
7. Mark Bowden, "Predator Drone," *Smithsonian Magazine*, 41 (7) (November 2013): 53–56.
8. Amitai Etzioni, "The Great Drone Debate," *Military Review*, 93 (2) (March–April 2013): 2.
9. See U.S. Air Force, *Factsheet: MQ-1B Predator*, (Washington, DC: U.S. Air Force, 2010): 1–2; http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104469/mq-1b-predator.aspx; Accessed June 16, 2017; and U.S. Government Accountability Office, *Defense Acquisitions: Assessments of Selected Weapons Programs*, (Washington, DC: GAO, 2013): 101; http://www.gao.gov/assets/660/653379.pdf; Accessed June 17, 2017
10. See U.S. Air Force, *Factsheet: MQ-9 Reaper*, (Washington, DC: U.S. Air Force, 2010): 1–2; http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104470/mq-9-reaper.aspx; Accessed June 17, 2017; and *Defense Acquisitions: Assessments of Selected Weapons Programs*, 105.
11. See U.S. Air Force, *Factsheet: RQ-4 Global Hawk*, (Washington, DC: U.S. Air Force, 2014): 1–2; http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104516/rq-4-global-hawk.aspx; Accessed June 17, 2017; *Defense Acquisitions: Assessments of Selected Weapons Programs*, 113; and U.S. Department of Defense, Office of the Undersecretary of Defense (Comptroller)/Chief Financial Officer, *Program Acquisition Cost by Weapon System*, (Washington, DC: DOD, 2013): 1–4; http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2014/FY2014_Weapons.pdf; Accessed June 17, 2017.

12. United Nations, Division for Ocean Affairs and Law of the Sea, *Submission by China*, (New York: United Nations Commission on Law of the Sea (UNCLOS), May 7, 2009): 1–2; http://www.un.org/depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2009re_mys_vnm_e.pdf; Accessed June 17, 2017.
13. Jun Ozawa, *China's ADIZ Over the East China Sea: A "Great Wall in the Sky"?*, (Washington, DC: Brookings Institution, 2013): http://www.brookings.edu/research/opinions/2013/12/17-china-air-defense-identification-zone-osawa; Accessed June 17, 2017.
14. See Bert Chapman, "China's Nine-Dashed Map: Maritime Source of Geopolitical Tension," *Geopolitics, History, and International Relations*, 8 (1) (2016): 155–157; http://docs.lib.purdue.edu/lib_fsdocs/121/; Accessed June 17, 2017; and Japan, Ministry of Defense, "Statistics on Scrambles During the First Quarter of FY 2016): 1, 4; http://www.mod.go.jp/js/Press/press2016/press_pdf/p20161014_06.pdf; Accessed May 30, 2018.
15. See Lawrence E. Grinter, *Chinese Military Scenarios Against Taiwan: Premises, Options, Implications*, (Maxwell AFB, AL: USAF Counterproliferation Center, 2002): http://www.au.af.mil/au/awc/awcgate/cpc-pubs/grinter.pdf; Accessed June 17, 2017; The *Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, Richard P. Hallion, Roger Cliff, and Phillip C. Saunders, eds., (Washington, DC: National Defense University Press, 2012); www.ndu.edu/press/lib/pdf/books/chinese-air-force.pdf; Accessed June 17, 2017.
16. U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, (Washington, DC: DOD, 2015): 8–11; http://www.defense.gov/pubs/2015_China_Military_Power_Report.pdf; Accessed June 17, 2017.
17. Ibid., 11.
18. See Ibid., 11–12; and U.S. Congress, House Committee on Armed Services, Subcommittee on Seapower and Projection Forces, *Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) Requirements Assessment*, (Washington, DC: GPO, 2015): http://purl.fdlp.gov/GPO/gpo56620; Accessed June 17, 2017. Literature on Chinese Anti-Access Aerial Denial includes Christopher D. Yung, "Sinica Rules the Waves?: The People's Liberation Army Navy's Power Projection and Anti-Access/Aerial Denial Lessons From the Falklands/Malvinas Conflict," in *Chinese Lessons from Other People's Wars*, Andrew Scobell, David Lai, and Roy Kamphausen, eds., (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2011): 75–114; http://www.strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1090; Accessed June 17, 2017; Ronald Wilgenbusch and Alan Heisig, "Command and Control Vulnerabilities to Communications Jamming," *Joint Force Quarterly*, 69 (2nd Quarter 2013): 56–63; http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-69/

JFQ-69_56-63_Wilgenbusch-Heisig.pdf; Accessed June 17, 2017; James M. Keagle, Richard D. Fisher, Jr., and Brian Johnson, "Enhancing the U.S. Rebalance Toward Asia: Elevating Allies," *Joint Force Quarterly*, 70 (3rd Quarter 2013): 59–65; http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-70/JFQ-70_59-65_Keagle-Fisher-Johnson.pdf; Accessed June 17, 2017; *Beyond the Wall: Chinese Far Sea Operations*, Peter A. Dutton and Ryan A. Martinson, eds., (Newport: U.S. Naval War College, Chinese Maritime Studies Institute, 2015); http://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1012&context=cmsi-red-books; Accessed May 30, 2018; William H. Ballard, Mark C. Harysch, Kevin J. Cole, and Brian S. Hall, "Operationalizing Air-Sea Battle in the Pacific," *Air & Space Power Journal*, 29 (1)(January–February 2015): 20–47; http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2015-Jan-Feb/F-Ballard_Harysch_Cole_Hall.pdf; Accessed June 17, 2017; and *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, 33–38.

19. Ibid., 11–12.
20. Ibid., 80.
21. Kimberly Hsu, Craig Murray, Jeremy Cook, and Amalia Field, *China's Military Unmanned Aerial Vehicle Industry*, (Washington, DC: U.S.-China Economic and Security Review Commission, 2013): http://origin.www.uscc.gov/sites/default/files/Research/China%27s%20Military%20UAV%20Industry_14%20June%202013.pdf; Accessed June 19, 2017; U.S. Defense Science Board, *The Role of Autonomy in DOD Systems*, (Washington, DC: Defense Science Board, 2012): 71; http://www.acq.osd.mil/dsb/reports/AutonomyReport.pdf; Accessed June 19, 2017; and Tai Ming Cheung, "The Chinese Defense Economy's Long March from Imitation to Innovation," *Journal of Strategic Studies*, 34 (3)(June 2011): 325–354; https://doi.org/10.1080/01402390.2011.574976.
22. See U.S. Department of Defense, Air-Sea Battle Office, *Air-Sea Battle: Service Collaboration to Address Anti-Access and Area Denial Challenges*, (Washington, DC: DOD Air-Sea Battle Office, 2013): 4–7; http://archive.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf; Accessed June 17, 2017; Jan van Tol, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas, *AirSea Battle: A Point of Departure Operational Concept*, (Washington, DC: Center for Strategic and Budgetary Assessments, 2010); http://csbaonline.org/publications/2010/05/air-sea-battle-concept/; Accessed June 17, 2017.
23. See Jeffrey P. Kline and Wayne P. Hughes, Jr., "Between Peace and the Air-Sea Battle: A War at Sea Strategy," *Naval War College Review*, 65 (4) (Autumn 2012): 35–40; Aaron Friedberg, *Beyond Air-Sea Battle: The Debate Over U.S. Military Strategy in Asia*, (London: IISS, 2014); Amitai

Etzioni, "The Air-Sea Battle 'Concept': A Critique," *International Politics*, 51 (5)(2014): 577–596; https://doi.org/10.1057/ip.2014.27; David W. Kearn, Jr., "Air-Sea Battle and China's Anti-Access and Area Denial Challenge," *Orbis*, 58 (1)(Winter 2014): 132–146; https://doi.org/10.1016/j.orbis.2013.11.006; and Raymond Millen, "Air Sea Battle and the Danger of Fostering a Maginot Line Mentality," *Military Review*, 95 (2)(March–April 2015): 125–132.

24. Ronald O' Rourke, *China's Naval Modernization: Implications for U.S. Navy Capabilities-Background and Issues for Congress*, (Washington, DC: Library of Congress, Congressional Research Service, 2015): 48; https://www.fas.org/sgp/crs/row/RL33153.pdf; Accessed June 17, 2017.
25. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, 81.
26. Ibid., 82.
27. Ibid., 83.
28. Ibid., 85.
29. Ibid., 87–89. The concept of "tyranny of distance" as applied to the Pacific Ocean's vast geographic regions was originally used to describe Australia's onetime geographic isolation and inaccessibility in Geoffrey Blainey, *The Tyranny of Distance: How Distance Shaped Australia's History*, (Melbourne: Macmillan, 1968).
30. See *Getting Ready for a Nuclear-Ready Iran*, Henry Sokolski and Patrick Clawson, eds., (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2005); U.S. Congress, House Committee on Armed Services, *Addressing the Iranian Nuclear Challenge: Understanding the Military Options*, (Washington, DC: GPO, 2012): http://purl.fdlp.gov/GPO/gpo32363; Accessed May 18, 2017; U.S. Department of State, Bureau of Counterterrorism, *Country Reports on Terrorism, 2013*, (Washington, DC: Department of State, 2014): 228–230; http://www.state.gov/documents/organization/225886.pdf; Accessed May 18, 2017; Shahram Chubin, "Is Iran a Military Threat," *Survival: Global Politics and Strategy*, 56 (2)(2014): 65–88; https://doi.org/10.1080/00396338.2014.901733; Accessed June 18, 2015; U.S. Congress, House Committee on Armed Services, *P5+1 Negotiations Over Iran's Nuclear Program and Its Implications for United States Defense*, (Washington, DC: GPO, 2015); http://purl.fdlp.gov/GPO/gpo54839; Accessed June 18, 2017; and Vipin Narang, "Nuclear Strategies of Emerging Nuclear Powers: North Korea and Iran," *The Washington Quarterly*, 38 (1)(Spring 2015): 73–91; https://doi.org/10.1080/0163660X.2015.1038175.
31. See Anthony Cordesman, "The Conventional Military," in *The Iran Primer: Power, Politics, and U.S. Policy*, Robin Wright, ed., (Washington, DC: U.S. Institute of Peace Press, 2010): 66–69; and Stephen R. Ward, *Immortal: A Military History of Iran and Its Armed Forces*, (Washington, DC: Georgetown University Press, 2014).

32. See Ibid., Jonathan Herman, "Iran's Unconventional Counter U.S. Strategy," M.A. Thesis, (Johns Hopkins University, 2014); https://jscholarship.library.jhu.edu/bitstream/handle/1774.2/37306/HERMAN-THESIS-2014.pdf?sequence=1; Accessed June 18, 2017; and U.S. Office of Naval Intelligence, *Iranian Naval Forces: A Tale of Two Navies*. (Washington, DC: Office of Naval Intelligence, 2017): https://purl.fdlp.gov/GPO/gpo85530; Accessed December 19, 2017.
33. Anthony H. Cordesman, Scott Modell, Aaron Lin, and Michael Peacock, *Iran's Rocket and Missile Forces and Strategic Options*, (Washington, DC: Center for Strategic and International Studies, 2014): iv–v; http://csis.org/files/publication/141007_Iran_Rocket_Missile_forces.pdf; Accessed June 18, 2017.
34. See Mark Manyin, Mary Beth Nikitin, Emma Chanlett-Avery, Ian E. Rinehart, and William H. Cooper, *U.S.-South Korea Relations*, (Washington, DC: Library of Congress, Congressional Research Service, 2013); http://digital.library.unt.edu/ark:/67531/metadc462192/m1/1/high_res_d/R41481_2013Apr26.pdf; Accessed June 19, 2017; and "Cross-Border Shootout," *Korea Times*, October 12, 2014.
35. National Air and Space Intelligence Center, *Ballistic & Cruise Missile Threat 2017*, (Wright Patterson AFB, OH: NASIC 2017): 21; https://www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat_Final_small.pdf?ver=2017-07-21-083234-343; Accessed August 20, 2018.
36. Ibid., 25.
37. Ibid., 29.
38. U.S. Department of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea 2013: Annual Report to Congress*, (Washington, DC: DOD, 2013): 16; http://www.defense.gov/pubs/North_Korea_Military_Power_Report_2013-2014.pdf; Accessed June 19, 2017.
39. Ibid., 17.
40. Ibid., 18.
41. See Andrew Scobell and John M. Sanford, *North Korea's Military Threat: Pyongyang's Conventional Forces, Weapons of Mass Destruction, and Ballistic Missiles*, (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2007); http://www.strategicstudiesinstitute.army.mil/pdffiles/PUB771.pdf; Accessed June 19, 2017; and Ibid., 12–13.
42. See Oh Jae-hwan, "Security Agencies of North Korea Under the Kim Jong Un Regime," *The Korean Journal of Defense Analysis*, 26 (1)(March 2014): 117–131; Paul K. Kerr, Mary Beth D. Nikitin, and Steven A. Hildreth, "Iran-North Korea-Syria Ballistic Missile and Nuclear Cooperation," *Current Politics and Economics of the Middle East*, 5 (1)(2014): 1–16.

43. See "Japan: Russian Incursions Into Airspace Have More Than Doubled in Six Months," *Washington Times*, (October 21, 2014): http://www.washingtontimes.com/news/2014/oct/21/japan-russian-incursions-into-airspace-have-more-t/; Accessed June 19, 2017; Roy Allison, "Russian 'Deniable' Intervention in Ukraine: How and Why Russia Broke the Rules," *International Affairs*, 90 (6)(November 2014): 1255–1297; https://doi.org/10.1111/1468-2346.12170; Roland Oliphant, "Mapped: Just How Many Incursions into NATO Airspace Has Russian Military Made?," *London Daily Telegraph*, (May 15, 2015); http://www.telegraph.co.uk/news/worldnews/europe/russia/11609783/Mapped-Just-how-many-incursions-into-Nato-airspace-has-Russian-military-made.html; Accessed June 19, 2017; Stockholm International Peace Research Institute, *SIPRI Military Expenditure Database*, (Stockholm: SIPRI, 2018); https://www.sipri.org/databases/milex; Accessed May 30, 2018; Richard Weitz, *Parsing Chinese-Russian Military Exercises*, (Carlisle, PA: U.S. Army War College Press, 2015); http://strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1266; Accessed June 19, 2017; and *From Cooperation to Competition: The Future of U.S.-Russian Relations: A Report on an Interdisciplinary War Game*, (Carlisle, PA: U.S. Army War College Press, 2015); http://strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1283; Accessed June 19, 2015; and Thomas Frear, *List of Close Military Encounters Between Russia and the West: March 2014–March 2015*, (London: European Leadership Network, 2015); http://www.europeanleadershipnetwork.org/medialibrary/2015/03/11/4264a5a6/ELN%20Russia%20-%20West%20Full%20List%20of%20Incidents.pdf; Accessed June 19, 2017.
44. See Alexander Ghaleb, *Natural Gas as an Instrument of Russian State Power*, (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2011); and *From Cooperation to Competition*, 9.
45. Ariel Cohen, *Backgrounder: A U.S. Response to Russia's Military Modernization*, (Washington, DC: The Heritage Foundation, 2014): 5; http://thf_media.s3.amazonaws.com/2014/pdf/BG2901.pdf; Accessed June 19, 2017.
46. See Ibid., 9–10; Lukáš Tichỳa, "Security and Foreign Policy of Dmitry Medvedev in the Period 2008–2012," *The Journal of Slavic Military Studies*, 27 (4)(2014): 533–552, https://doi.org/10.1080/13518046.2014.963398; and Bert Chapman, "Atomic Weapons Program, Soviet," in *Russia at War: From the Mongol Conquest to Afghanistan, Chechnya, and Beyond*, Timothy C. Dowling, ed., (Santa Barbara: ABC-CLIO, 2015): 69–70; http://docs.lib.purdue.edu/lib_fsdocs/91/; Accessed June 19, 2017.
47. *Ballistic and Cruise Missile Threat*, 13.
48. Ibid., 21.

49. See “Combat Robot Companies Enter the Table of Organizational Equipment,” *OE Watch*, 5 (1) (January 2015): 50–52; https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195464; Accessed June 22, 2017; and Cindy Hurst, “The Militarization of Gazprom,” *Military Review*, 90 (5 September–October 2010): 59–67; http://www.armyupress.army.mil/Portals/7/military-review/Archives/English/MilitaryReview_20101031_art010.pdf; Accessed December 19, 2017.
50. Russian Armed Forces UAV Developments in 2014,” *OE Watch*, 5 (2), (February 2015): 56–57; https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195463. Accessed June 22, 2017.
51. See “U.S. Says Russia Adds Air Defense Systems Inside Ukraine,” *VOA News*, April 22, 2015; 1; http://www.voanews.com/content/reu-us-says-russia-adds-air-defense-systems-inside-ukraine/2731074.html; Accessed June 22, 2017; Ibid., 56; and Conor Sullivan, Schuyler Standley, and James M. Keagle, “Responding to Russia after the NATO Summit: Unmanned Aerial Systems Overmatch in the Black Sea,” *Defense Horizons*, 79 (April 2015): 1–8; http://ndupress.ndu.edu/Portals/68/Documents/defense-horizon/DH-79.pdf; Accessed June 22, 2017.
52. See Michael Pelosi and Carlo Kopp, “A Preliminary Assessment of Specular Radar Cross Section Performance in the Sukhoi T-50 Prototype,” *Air Power Australia Analyses*, 9 (2012–03); http://www.ausairpower.net/APA-2012-03.html; Accessed June 22, 2017; Zachary Keck, “Is Russia’s Lethal PAK-FA Fighter Stealthier Than America’s F-22,” *The National Interest*, (May 26, 2015): 1–2; http://nationalinterest.org/blog/the-buzz/russias-lethal-pak-fa-fighter-stealthier-americas-f-22-12972; Accessed June 22, 2017; and Dave Majumdar, “The Russian Air Force’s Super Weapon: Beware the PAK-FA Stealth Fighter, *The National Interest*, (November 26, 2014): 1–2; http://nationalinterest.org/feature/the-russian-air-forces-super-weapon-beware-the-pak-fa-11742; Accessed June 22, 2017.
53. Jennifer Griffin, “Budget Cuts Impact US Ability to Fight the Enemy, Air Force General Warns,” *Fox News*, (May 26, 2015): 1–4; http://www.foxnews.com/politics/2015/05/26/budget-cuts-impact-us-ability-to-fight-enemy-air-force-general-warns/; Accessed June 22, 2017. For foreign espionage against the JSF see Siobhan Gorman, August Cole, and Yochi Dreazen, “Computer Spies Breach Fighter Jet Project,” *Wall Street Journal*, (April 21, 2009): A1; U.S.-China Economic and Security Review Commission, *2009 Report to Congress*, (Washington, DC: GPO, 2009): 167; https://www.uscc.gov/sites/default/files/annual_reports/2009-Report-to-Congress.pdf; Accessed December 19, 2017; Magnus Hjortdal, “China’s Use of Cyber Warfare: Espionage Meets Strategic Deterrence,” *Journal of Strategic Security*, 4 (2)(Summer 2011): 1–24; http://scholarcommons.usf.edu/jss/vol4/iss2/2/; Accessed June 22, 2017; and Amitai Etzioni,

"Cybersecurity in the Private Sector," *Issues in Science and Technology*, 28 (1) (Fall 2011): 59; and U.S. Congress, House Committee on Armed Services, *The State of the Military*, (Washington, DC: GPO, 2017): 75–80; https://www.govinfo.gov/content/pkg/CHRG-115hhrg24676/pdf/CHRG-115hhrg24676.pdf; Accessed May 31, 2018.

54. See Marco Wyss, "Clashing Over Fighters: Winners and Losers," *CSS Analysis in Security Policy*, 92 (2011): 1–3; http://e-collection.library.ethz.ch/eserv/eth:2957/eth-2957-01.pdf; Accessed June 22, 2017; and Julian Cooper, "The Military Dimension of a More Militant Russia," *Russian Journal of Economics*, 2 (2016): 143; https://doi.org/10.1016/j.ruje/2016.06.002.
55. See The State Council of the People's Republic of China, *Made in China 2025*, (Beijing: The State Council, 2016); 1–3; http://english.gov.cn/2016special/madeinchina2025/; Accessed May 30, 2018; Michael Raska, "China's Defence Aviation Industry: Searching for Innovation-Analysis," *Eurasia Review*, (October 18, 2012): 1–4; http://www.eurasiareview.com/18102012-chinas-defence-aviation-industry-searching-for-innovation-analysis/; Accessed May 30, 2018; and Alexander Hammer, "Made in China 2025" Attempts to Re-Stimulate Domestic Innovation," (Washington, DC: U.S. International Trade Commission, September 2017): 1–2; http://usitc.gov/publications/332/executive_briefings/ebot_madeinchina2025hammer.pdf; Accessed May 30, 2018; and Scott Kennedy, *The Fat Tech Dragon: Benchmarking China's Innovation Drive*, (Washington, DC: Center for Strategic and International Studies, 2017). https://csis-prod.s3.amazonaws.com/s3fs-public/publication/170829_Kennedy_FatTechDragon_Web.pdf?.6agddecKW.hKNzCkVYvvUSDsQCeK9mN. Accessed May 30, 2018.
56. See Gallup Organization. Gallup Poll, Feb, 2015 [survey question]. USGALLUP.022015.R01. Gallup Organization. Storrs, CT: Roper Center for Public Opinion Research, *iPOLL*, accessed June 22, 2017; Politico/Harvard Public Health Poll, Aug. 2017 [survey question]. USSSRS091517PH.R01H., Cornell Roper Center for Public Opinion Research, *iPOLL*, Accessed December 19, 2017; and Henry J. Kaiser Family Foundation, *Kaiser Health Tracking Poll*, Nov. [2017] [survey question]. USSSRS.111517K.R06E, Cornell University: Roper Center for Public Opinion Research, *iPOLL*, Accessed December 19, 2017.
57. *2017 Index of U.S. Military Strength*, Dakota Wood, ed., (Washington, DC: The Heritage Foundation, 2016); http://ims-2017.s3.amazonaws.com/2017_Index_of_Military_Strength_WEB.pdf; 6, 81, 213–214, 247–249, 275, Accessed June 22, 2017.
58. Ibid., 301–305.
59. Ibid., 316.
60. Ibid., 380.
61. Ibid., 316–317.

References

2017 Index of U.S. Military Strength. Edited by Dakota Wood (Washington, DC: The Heritage Foundation, 2017). http://ims-2017.s3.amazonaws.com/2017_Index_of_Military_Strength_WEB.pdf. Accessed May 31, 2018.

Airpower in Afghanistan 2005–2010: The Air Commanders' Perspectives. Edited by Dag Henriksen (Maxwell AFB, AL: Air University Press, 2014). http://www.au.af.mil/au/aupress/digital/pdf/book/b_0000_henriksen_commanders_perspectives.pdf. Accessed June 16, 2017.

Allison, Roy. "Russian 'Deniable" Intervention in Ukraine: How and Why Russia Broke the Rules." *International Affairs*, 90 (6) (November 2014): 1255–1297. https://doi.org/10.1111/1468-2346.12170.

Al-Khuzaa'l, Qaa'id K.M. "The Use of Airpower in Combating Terrorism in Iraq." *Air and Space Power Journal*, 32 (1) (Spring 2009): 11–18. http://www.airpower.au.af.mil/airchronicles/apj/apj09/spr09/alkhuzaai.html. Accessed June 16, 2017.

The American Way of Bombing: Changing Ethical and Legal Norms from Flying Fortresses to Drones, edited by Matthew Evangelista and Henry Shue (Ithaca: Cornell University Press, 2014).

Ballard, William H., Mark C. Harysch, Kevin J. Cole, and Brian S. Hall. "Operationalizing Air-Sea Battle in the Pacific." *Air & Space Power Journal*, 29 (1) (January–February 2015): 20–47. http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2015-Jan-Feb/F-Ballard_Harysch_Cole_Hall.pdf. Accessed June 17, 2017.

Beyond the Wall: Chinese Far Sea Operations. Edited by Peter A. Dutton and Ryan A. Martinson (Newport: U.S. Naval War College, China Maritime Studies Institute, 2015). http://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1012&context=cmsi-red-books. Accessed December 19, 2017.

Blainey, Geoffrey. *The Tyranny of Distance: How Distance Shaped Australia's History* (Melbourne: Macmillan, 1968).

Blair, Dave. "Ten Thousand Feet and Ten Thousand Miles: Reconciling Our Air Force Culture to Remotely Piloted Aircraft and the New Nature of Aerial Combat." *Air & Space Power Journal*, 26 (3) (May–June 2012): 61–69. http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2012-May-Jun/V-Blair.pdf. Accessed June 16, 2017.

Bowden, Mark. "Predator Drone." *Smithsonian Magazine*, 41 (7) (November 2013): 53–56.

Boyle, Michael J. "The Race for Drones." *Orbis*, 59 (1) (Winter 2015): 76–94. https://doi.org/10.1016/j.orbis.2014.11.007.

Cantwell, Houston R. "Operators of Air Force Unmanned Systems: Breaking Paradigms." *Air & Space Power Journal*, 23 (2) (Summer 2009): 67–77. http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2012-May-Jun/V-Blair.pdf. Accessed December 19, 2017.

Chapman, Bert. "Atomic Weapons Program, Soviet." In *Russia At War: From the Mongol Conquest to Afghanistan, Chechnya, and Beyond*, edited by Timothy C. Dowling, 69–70 (Santa Barbara: ABC-CLIO, 2015). http://docs.lib.purdue.edu/lib_fsdocs/91/. Accessed June 19, 2017.

———. "China's Nine-Dashed Map: Maritime Source of Geopolitical Tension." *Geopolitics, History, and International Relations*, 8 (1) (2016): 155–157. http://docs.lib.purdue.edu/lib_fsdocs/121/. Accessed February 8, 2017.

Cheung, Tai Ming. "The Chinese Defense Economy's Long March from Imitation to Innovation." *Journal of Strategic Studies*, 34 (3) (June 2011): 325–354. https://doi.org/10.1080/01402390.2011.574976.

The Chinese Air Force: Evolving Concepts, Roles, and Capabilities. Edited by Richard P. Hallion, Roger Cliff, and Phillip C. Saunders (Washington, DC: National Defense University Press, 2012). http://www.ndu.edu/press/lib/pdf/books/chinese-air-force.pdf. Accessed June 17, 2017.

Chubin, Shahram. "Is Iran a Military Threat?" *Survival: Global Politics and Strategy*, 56 (2) (2014): 65–88. https://doi.org/10.1080/00306338.2014.91733.

Cohen, Ariel. *Backgrounder: A U.S. Response to Russia's Military Modernization* (Washington, DC: The Heritage Foundation, 2014). http://thf_media.s3.amazonaws.com/2014/pdf/BG2901.pdf. Accessed June 19, 2017.

"Combat Robot Companies Enter the Table of Organizational Equipment." *OE Watch*, 5 (1) (January 2015): 50–52. https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195464. Accessed June 22, 2017.

Combating Terrorism: Strategies of Ten Countries. Edited by Yonah Alexander (Ann Arbor: University of Michigan Press, 2002).

Cooper, Julian. "The Military Dimension of a More Militant Russia." *Russian Journal of Economics*, 2 (2016): 143. https://doi.org/10.1016/j.ruje/2016.06.002.

Cordesman, Anthony. "The Conventional Military." In *The Iran Primer: Power, Politics, and U.S. Policy*, edited by Robin Wright, 66–69 (Washington, DC: U.S. Institute of Peace Press, 2010).

Cordesman, Anthony, Scott Modell, Aaron Lin, and Michael Peacock. *Iran's Rocket and Missile Forces and Strategic Options* (Washington, DC: Center for Strategic and International Studies, 2014). http://csis.org/files/publication/141007_Iran_Rocket_Missile_forces.pdf. Accessed December 19, 2017.

Corum, James S., and Wray R. Johnson. *Airpower in Small Wars: Fighting Insurgents and Terrorists* (Lawrence: University Press of Kansas, 2003).

"Cross-Border Shootout." *Korea Times* (October 12, 2014).

Davies, Andrew, and James Mugg. "Submission to Foreign Affairs, Defence and Trade Committee Inquiry into the Planned Acquisition of the F-35 Lightning II (Joint Strike Fighter)." *Australian Strategic Policy Institute* (February 19, 2016). https://www.aph.gov.au/DocumentStore.ashx?id=47ef7aab=5ff8-43e1-a2ce-9810f29290e3&subid=409407. Accessed August 14, 2018.

Defense Intelligence Agency. "Russia Military Power: Building a Military to Support Great Power Aspirations." (2017). http://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Russia%20Military%20Power%20Report%202017.pdf. Accessed August 14, 2018.

Drone Wars: Transforming Conflict, Law, and Policy. Edited by Peter L. Bergen and Daniel Rothenberg (New York: Cambridge University Press, 2014).

Etzioni, Amitai. "Cybersecurity in the Private Sector." *Issues in Science and Technology*, 28 (1) (Fall 2011): 59.

———. "The Great Drone Debate." *Military Review*, 93 (2) (March–April 2013): 2.

———. "The Air-Sea Battle 'Concept': A Critique." *International Politics*, 51 (5) (2014): 577–596. https://doi.org/10.1057/ip.2014.27.

Frear, Thomas. *List of Close Military Encounters Between Russia and the West: March 2014–March 2015* (London: European Leadership Network, 2015). http://www.europeanleadershipnetwork.org/medialibrary/2015/03/11/4264a5a6/ELN Russia - West Full List of Incidents.pdf. Accessed June 19, 2017.

Friedberg, Aaron. *Beyond Air-Sea Battle: The Debate Over U.S. Military Strategy* (London: IISS, 2014).

From Cooperation to Competition: The Future of U.S.-Russian Relations: A Report on an Interdisciplinary War Game (Carlisle, PA: U.S. Army War College Press, 2015). http://strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1283. Accessed June 19, 2017.

Gallup Organization. *Gallup Poll* (February 2015) [survey question]. USGALLUP.022015.R01. Gallup Organization. Storrs, CT: Roper Center for Public Opinion Research, *iPOLL*. Accessed June 22, 2017.

Ganguly, Sumit. "Nuclear Stability in South Asia." *International Security*, 33 (2) (Fall 2008): 45–70.

"*Getting Ready for a Nuclear-Ready Iran*." Edited by Henry Sokolski and Patrick Clawson (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2005).

Ghaleb, Alexander. *Natural Gas as an Instrument of Russian State Power* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2011).

Gorman, Siobhan, August Cole, and Yochi Dreazen. "Computer Spies Breach Fighter Jet Project." *Wall Street Journal* (April 21, 2009): A1.

Gray, Colin S. *Air Power for Strategic Effect* (Maxwell AFB, AL: Air University Press, 2012). http://purl.fdlp.gov/GPO?GO56522. Accessed June 16, 2017.

Griffin, Jennifer. "Budget Cuts Impact U.S. Ability to Fight the Enemy, Air Force General Warns." *Fox News* (May 26, 2015): 1–4. http://www.foxnews.com/politics/2015/05/26/budget-cuts-impact-us-ability-to-fight-enemy-air-force-general-warns.html. Accessed June 22, 2017.

Grinter, Lawrence E. *Chinese Military Scenarios Against Taiwan: Premises, Options, Implications* (Maxwell, AFB, AL: USAF Counterproliferation Center, 2002). http://www.au.af.mil/au/awc/awcgate/cpc-pubs/grinter.pdf. Accessed June 17, 2017.

Gunter, Michael. "Iraq, Syria, ISIS, and the Kurds: Geostrategic Concerns for the U.S. and Turkey." *Middle East Policy*, 22 (1) (Spring 2015): 102–111.

Hammer, Alexander. "Made in China 2025" Attempts to Re-Stimulate Domestic Innovation." (Washington, DC: U.S. International Trade Commission, September 2017): 1–2. http://usitc.gov/publications/332/executive_briefings/ebot_madeinchina2025hammer.pdf. Accessed May 30, 2018.

Harrison, Ross. "Confronting the Islamic State': Towards a Regional Strategy Contra ISIS." *Parameters*, 44 (3) (Autumn 2014): 39–46.

Hassan, Hussein D. "CRS Report for Congress: Iranian Nuclear Sites." *Congressional Research Service, Library of Congress* (August 9, 2007). https://digital.library.unt.edu/ark:/67531/metadc814935/m2/1/high_res_d/RS22531_2007Aug09.pdf. Accessed August 14, 2018.

Herman, Jonathan. "Iran's Unconventional Counter U.S. Strategy." M.A. Thesis (Johns Hopkins University, 2014). https://jscholarship.library.jhu.edu/bitstream/handle/1774.2/37306/HERMAN-THESIS-2014.pdf?sequence=1. Accessed June 18, 2017.

Hjortdal, Magnus. "China's Use of Cyber Warfare: Espionage Meets Strategic Deterrence." *Journal of Strategic Security*, 4 (2) (Summer 2011): 1–24. http://scholarcommons.usf.edu/jss/vol4/iss2/2/. Accessed June 22, 2017.

Hsu, Kimberly, Craig Murray, Jeremy Cook, and Amalia Field. *China's Military Unmanned Aerial Vehicle Industry* (Washington, DC: U.S.-China-Economic and Security Review Commission, 2013). http://origin.www.uscc.gov/sites/default/files/Research/China%27s Military UAV Industry_14 June 2013.pdf. Accessed June 19, 2017.

Hurst, Cindy. "The Militarization of Gazprom." *Military Review*, 90 (5) (September–October 2010): 59–67. http://www.armyupress.army.mil/Portals/7/military-review/Archives/English/MilitaryReview_20101031_art010.pdf. Accessed December 19, 2017.

Jae-hwan, Oh. "Security Agencies of North Korea Under the Kim Jong Un Regime." *The Korean Journal of Defense Analysis*, 26 (1) (March 2014): 117–131.

Japan. Ministry of Defense. "Statistics on Scrambles During the First Quarter of FY 2016." (Tokyo: Ministry of Defense, 2016): 1, 4. http://www.mod.go.jp/js/Press/press2016/press_pdf/p20161014_06.pdf. Accessed May 30, 2018.

"Japan: Russian Incursions Into Airspace Have More Than Doubled in Six Months." *Washington Times* (October 21, 2014). https://www.washingtontimes.com/news/2014/oct/21/japan-russian-incursions-into-airspace-have-more-t/. Accessed June 10, 2017.

Kaiser, Henry J. Family Foundation. Kaiser Health Tracking Poll (November 2017). [survey question]. USSSRS111517.KR06E. Cornell University: Roper Center for Public Opinion Research, *iPOLL*. Accessed December 19, 2017.

Keagle, James M., Richard D. Fisher, Jr., and Brian Johnson. "Enhancing the U.S. Rebalance Toward Asia: Elevating Allies." *Joint Force Quarterly*, 70 (3rd Quarter 2013): 59–65. http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-70/JFQ-70_59-65_Keagle-Fisher-Johnson.pdf. Accessed June 17, 2017.

Kearn, Jr. David W. "Air-Sea Battle and China's Anti-Access and Area Denial Challenge." *Orbis*, 58 (1) (Winter 2014): 132–146. https://doi.org/10.1016/j.orbis.2013.1106.

Keck, Zachary. "Is Russia's Lethal PAK-FA Fighter Stealthier Than America's F-22." *The National Interest* (May 26, 2015): 1–2. http://nationalinterest.org/blog/the-buzz/russias-lethal-pak-fa-fighter-stealthier-americas-f-22-12972. Accessed June 22, 2017.

Kennedy, Scott. *The Fat Tech Dragon: Benchmarking China's Innovation Drive* (Washington, DC: Center for Strategic and International Studies, 2017).

Kerr, Paul K., Mary Beth D. Nikitin, and Steven A. Hildreth. "Iran-North Korea-Syria Ballistic Missile and Nuclear Cooperation." *Current Politics and Economics of the Middle East*, 5 (1) (2014): 1–16.

Kline, Jeffrey P., and Wayne P. Hughes, Jr. "Between Peace and the Air-Sea Battle: A War at Sea Strategy." *Naval War College Review*, 65 (4) (Autumn 2012): 35–40.

Kukreja, Dhiraj. "Air Power: Future Challenges and Emerging Roles." *Air Power Journal*, 9 (3) (July–September 2014): 55–78. http://capsindia.org/files/documents/APJ-Jul-Sep-2014-inside.pdf. Accessed June 16, 2017.

Majumdfar, Dave. "The Russian Air Force's Super Weapon: Beware the PAK-FA Stealth Fighter." *The National Interest* (November 26, 2014): 1–2. http://nationalinterest.org/feature/the-russian-air-forces-super-weapon-beware-the-pak-fa-11742. Accessed June 22, 2017.

Manyin, Mark, Mary Beth Nikitin. Emma Chanlett-Avery, Ian E. Rinehart, and William H. Cooper. *U.S.-South Korea Relations* (Washington, DC: Library of Congress, Congressional Research Service, 2013). http://digital.library.unt.edu/ark:/67531/metadc462192/m1/1/high_res_d/R41481_2013Apr26.pdf. Accessed June 19, 2017.

"Medals for Drone Pilots." *The Economist*, 410 (8880) (March 29, 2014): 33.

Military Balance. (London: International Institute of Strategic Studies, 2016).

Millen, Raymond. "Air-Sea Battle and the Danger of Fostering a Maginot Line Mentality." *Military Review*, 95 (2) (March–April 2015): 125–132.

Narang, Vipin. "Nuclear Strategies of Emerging Nuclear Powers: North Korea and Iran." *The Washington Quarterly*, 38 (1) (Spring 2015): 73–91. https://doi.org/10.1080/0163660X.2015.1038175.

O'Brian, Kevin A. "Assessing Hostile Reconnaissance and Terrorist Intelligence Activities." *RUSI Journal*, 153 (3) (October 2008): 134–139.

O'Rourke, Ronald. *China's Naval Modernization: Implications for U.S. Navy Capabilities-Background and Issues for Congress* (Washington, DC: Library of

Congress, Congressional Research Service, 2017). https://www.fas.org/sgp/crs/row/RL33153.pdf. Accessed December 19, 2017.

Oliphant, Roland. "Mapped: Just How Many Incursions into NATO Airspace Has Russian Military Made?" *London Daily Telegraph* (May 15, 2015). https://www.telegraph.co.uk/news/worldnews/europe/russia/11609783/Mapped-Just-how-many-incursions-into-Nato-airspace-has-Russian-military-made.html. Accessed June 19, 2017.

Ozawa, Jun. *China's ADIZ Over the East China Sea: A "Great Wall in the Sky"*? (Washington, DC: Brookings Institution, 2013). http://www.brookings.edu/research/opinions/2013/12/17-china-air-defense-identification-zone-osawa. Accessed June 17, 2017.

Paust, Jordan J. "Self-Defense Targetings of Non-State Actors and Permissibility of U.S. Use of Drones in Pakistan." *Journal of Transnational Law and Policy*, 19 (2) (2010): 237–280.

Pelosi, Michael, and Carlo Kopp. "A Preliminary Assessment of Specular Radar Cross Section Performance in the Sukhoi T-50 Prototype." *Air Power Australia Analyses*, 9 (2012–03). http://www.ausairpower.net/APA-2012-03.html. Accessed June 22, 2017.

Politico/Harvard Public Health Poll. (August 2017) [survey question]. USSSRS.091517PH.R01H. Cornell Center for Public Opinion Research *iPOLL*. Accessed December 19, 2017.

Raska, Michael. "China's Defence Aviation Industry: Searching for Innovation-Analysis." *Eurasia Review* (October 18, 2012): 1–4. http://www.eurasiareview.com/18102012-chinas-defence-aviation-industry-searching-for-innovation-analysis/. Accessed May 30, 2018.

"Russian Armed Forces UAV Developments in 2014." *OE Watch*, 5 (2) (February 2015): 56–57. https://community.apan.org/wg/tradoc-g2/fmso/m/oe-watch-past-issues/195463. Accessed June 22, 2017.

Scobell, Andrew, and John M. Sanford. *North Korea's Military Threat: Pyongyang's Conventional Forces, Weapons of Mass Destruction, and Cruise Missiles* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2007). http://www.strategicstudiesinstitute.army.mil/pdffiles/PUB771.pdf. Accessed June 19, 2017.

Sloan, Stephen. *International Terrorism: An Action Strategy for Preemption and Punishment*. Rev. ed. (Maxwell AFB, AL: Air University Press, 2000). http://purl.access.gpo.gov/GPO/LPS204858. Accessed June 16, 2017.

The State Council of the People's Republic of China. *Made in China 2025* (Beijing: The State Council, 2016): 1–3. http://english.gov.cn/2016special/madeinchina2025/. Accessed May 30, 2018.

Stockholm International Peace Research Institute. *SIPRI Military Expenditure Database* (Stockholm: SIPRI, 2018). https://www.sipri.org/database/milex. Accessed May 30, 2018.

Sullivan, Conor, Schulyer Standley, and James M. Keagle. "Responding to Russia After the NATO Summit: Unmanned Aerial Systems Overmatch in the Black

Sea." *Defense Horizons*, 79 (April 2015): 1–8. http://ndupress.ndu.edu/Portals/68/Documents/defensehorizon/DH-79.pdf. Accessed June 22, 2017.

Thaler, David E., Theodore W. Kerasik, et al. *Future U.S. Security Relationships with Iraq and Afghanistan* (Santa Monica: Rand Corporation, 2008). https://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG681.pdf. Accessed June 16, 2017.

Tichỳa, Lukáš. "Security and Foreign Policy of Dmitry Medvedev in the Period 2008–2012." *The Journal of Slavic Military Studies*, 27 (4) (2014): 533–552. https://doi.org/10.1080/13518046.2014.963398.

U.S. Air Force. *Factsheet: MQ-1B Predator* (Washington, DC: U.S. Air Force, 2010a): 1–2. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104469/mq-1b-predator.aspx. Accessed June 16, 2017.

———. *Factsheet: MQ-9 Reaper* (Washington, DC: U.S. Air Force, 2010b): 1–2. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104470/mq-9-reaper.aspx. Accessed June 17, 2017.

———. *Factsheet: RQ-4 Global Hawk* (Washington, DC: U.S. Air Force, 2014): 1–2. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104516/rq-4-global-hawk.aspx. Accessed June 17, 2017.

U.S.-China Economic and Security Review Commission. *2009 Report to Congress* (Washington, DC: GPO, 2009). https://www.uscc.gov/sites/default/files/annual_reports/2009-Report-to-Congress.pdf. Accessed December 19, 2017.

U.S. Congress. House Committee on Armed Services. *Addressing the Iranian Nuclear Challenge: Understanding the Military Options* (Washington, DC: GPO, 2012). http://purl.fdlp.gov/GPO/gpo32363. Accessed May 18, 2017.

———. *P5+1 Negotiations Over Iran's Nuclear Program and Its Implications for United States Defense* (Washington, DC: GPO, 2015a. http://purl.fdlp.gov/GPO/gpo54839. Accessed June 18, 2017.

———. Subcommittee on Seapower and Projection Forces. *Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) Requirements Assessment* (Washington, DC: GPO, 2015b). http://purl.fdlp.gov/GPO/gpo56620. Accessed June 17, 2017.

———. *The State of the Military* (Washington, DC: GPO, 2017): 75–80. https://www.govinfo.gov/content/pkg/CHRG-115hhrg24676/pdf/CHRG-115hhrg24676.pdf. Accessed May 31, 2018.

U.S. Defense Science Board. *The Role of Autonomy in DOD Systems* (Washington, DC: Defense Science Board, 2012). https://www.acq.osd.mil/dsb/reports/2010s/AutonomyReport.pdf. Accessed June 19, 2017.

U.S. Department of Defense. Air-Sea Battle Office. *Air Sea-Battle: Service Collaboration to Address Anti-Access and Area Denial Challenges* (Washington, DC: DOD Air-Sea Battle Office, 2013a). http://archive.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf. Accessed June 17, 2017.

———. *Military and Security Developments Involving the Democratic People's Republic of Korea: Report to Congress* (Washington, DC: DOD, 2013b).

https://www.defense.gov/Portals/1/Documents/pubs/Report_to_Congress_on_Military_and_Security_Developments_Involving_the_DPRK.pdf. Accessed June 19, 2017.

———. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015* (Washington, DC: DOD, 2015a). http://www.defense.gov/pubs/2015_China_Military_Power_Report.pdf. Accessed June 17, 2017.

———. *Military and Security Developments Involving the People's Democratic Republic of Korea: Report to Congress* (Washington, DC: DOD, 2015b). https://www.defense.gov/Portals/1/Documents/pubs/Military_and_Security_Developments_Involving_the_Democratic_Peoples_Republic_of_Korea_2015.PDF. Accessed February 9, 2017.

———. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2016* (Washington, DC: DOD, 2016).

———. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2017* (Washington, DC: DOD, 2017a).

———. Office of the Undersecretary of Defense (Comptroller/Chief Financial Officer). *Program Acquisition Cost by Weapon System*. (Washington, DC: DOD, 2017b): 12. http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2014/FY2014_Weapons.pdf. Accessed December 19, 2017.

U.S. Department of State. Counterterrorism. Bureau. *Country Reports on Terrorism 2013* (Washington, DC: Department of State, 2014a). http://www.state.gov/documents/organization/225886.pdf. Accessed May 18, 2017.

———. *International Narcotics Control Strategy Report 2014* (Washington, DC: Department of State, 2014b). https://www.state.gov/j/inl/rls/nrcrpt/2014/. Accessed June 16, 2017.

———. *Trafficking in Persons Report 2014*. (Washington, DC: U.S. Department of State, 2014c). http://www.state.gov/j/tip/rls/tiprpt/2014/. Accessed June 16, 2017.

———. Counterterrorism Bureau. *Country Reports on Terrorism 2014* (Washington, DC: U.S. Department of State, 2015). http://www.state.gov/documents/organization/239631.pdf. Accessed June 23, 2017.

U.S. Government Accountability Office. *Defense Acquisitions: Assessments of Selected Weapons Programs* (Washington, DC: GAO, 2013): 101. http://www.gao.gov/assets/660/653379.pdf. Accessed June 17, 2017.

U.S. National Air and Space Intelligence Center. *Ballistic & Cruise Missile Threat 2017* (Wright-Patterson AFB, OH: NASIC, 2017). http://www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat_Final_small.pdf?ver=2017-07-21-083234-343. Accessed December 19, 2017.

U.S. Office of Naval Intelligence. *Iranian Naval Forces: A Tale of Two Navies* (Washington, DC: Office of Naval Intelligence, 2017). http://purl.gdlp.gov/GPO/gpo85530. Accessed December 19, 2017.

"U.S. Says Russia Adds Air Defense Systems Inside Ukraine." *VOA News* (April 22, 2015). https://www.voanews.com/a/reu-us-says-russia-adds-air-defense-systems-inside-ukraine/2731074.html. Accessed June 22, 2017.

United Nations. Division for Ocean Affairs and Law of the Sea. *Submission by China* (New York: United Nations Commission on Law of the Sea (UNCLOS), May 7, 2009): 1–2. http://www.un.org/depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2009re_mys_vnm_e.pdf. Accessed June 17, 2017.

Van Tol, Jan, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas. *AirSea Battle: A Point of Departure Operational Concept* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010). https://csbaonline.org/research/publications/airsea-battle-concept/. Accessed June 17, 2017.

Wall, Tyler, and Torin Monahan. "Surveillance and Violence from Afar: The Politics of Drones and Liminal Security-Scapes." *Theoretical Criminology*, 15 (3) (2011): 239–254. https://doi.org/10.1177/1362480610396650.

Ward, Stephen R. *Immortal: A Military History of Iran and Its Armed Forces* (Washington, DC: Georgetown University Press, 2014).

Weitz, Richard. *Parsing Chinese-Russian Military Exercises* (Carlisle, PA: U.S. Army War College Press, 2015). http://strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1266. Accessed June 19, 2017.

Wilgenbusch, Ronald, and Alan Heisig. "Command and Control Vulnerabilities to Communications Jamming." *Joint Force Quarterly*, 69 (2nd Quarter 2013): 56–63. http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-69/JFQ-69_56-63_Wilgenbusch-Heisig.pdf. Accessed June 17, 2017.

Wyss, Marco. "Clashing Over Fighters: Winners and Losers." *CSS Analysis in Security Policy*, 92 (2011): 1–3. http://e-collection.library.ethz.ch/eserv/eth:2957/eth-2957-01.pdf. Accessed June 22, 2017.

Yung, Christopher D. "Sinica Rules the Waves?: The People's Liberation Army Navy's Power Projection and Anti-Access/Aerial Denial Lessons from the Falklands/Malvinas Conflict." In *Chinese Lessons from Other People's Wars*, edited by Andrew Scobell, David Lai, and Roy Kamphausen, 75–114 (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2011). http://www.strategicstudiesinstitute.army.mil/pubs/download.cfm?q=1090. Accessed June 17, 2017.

CHAPTER 4

JSF and the United States

The US experience with the F-35 JSF has often seemed like a Sisyphean endeavor, making periodic progress, but repeatedly plagued by cost overruns, delays, and other setbacks which have made it appear that its completion and successful deployment will never be achieved. This chapter attempts to document the US historical development and evolution of the JSF in its nearly quarter-century lifespan. The history of US military weapons systems development is extremely complex and filled with withering criticisms, successes, failures, corruption, and incompetence, and future US military weapons systems development will never be filled with anything less than significant complexity and uncertainty.[1]

JSF was initially envisioned as a relatively "affordable" fifth-generation fighter for the Air Force, Marine Corps, and Navy in an attempt to avoid higher costs of developing, procuring, operating, and supporting three separate aircraft designs to meet these services' similar but not identical operational requirements. The services' three versions are intended to be equipped with single-seat aircraft capable of being supersonic for short periods of time and having advanced stealth characteristics. The intended three service versions include the Air Force's Conventional Take-Off and Landing (CTOL) F-35A to replace existing F-15, F-16, and A-10 aircraft; the Marine Corps Short Take-Off and Vertical Landing (STOVL) F-35B to replace AV-8B Harrier STOVL aircraft and the Marine Corps CTOL F/A-18/A/B/C/D/strike fighters; and the Navy's carrier suitable F-35C to replace the F/A-18E/F.[2]

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_4

JSF Capabilities

JSF technical, operational, and armament capabilities for individual variants are extremely advanced as Table 4.1 demonstrates.

Historical Overview and Evolution 1990s

JSF's protracted historical development and evolution began during the during the late 1980s and early 1990s as the military and the DOD sought to cope with a changing post-Cold War international security environment, the need to incorporate emerging technology into jet fighter platforms, and the need to produce more cost-effective weapons systems.

This time period saw agencies such as the Defense Advanced Research Projects Agency (DARPA) work with industries such as Lockheed, Pratt & Whitney, and General Electric, along with the Air Force and Navy on developing a new affordable lightweight fighter capable of meeting the needs of these armed service branches. The Clinton Administration's opening months in 1993 saw the DOD begin a Bottom-Up Review (BUR) of US military forces and modernization plans. A key BUR objective was seeking to rationalize five concurrently occurring tactical aircraft development programs: the Air Force's F-22 and Multirole Fighter (MRF) programs; the Navy's F/A-18E/F and A/F-X programs; and DARPA's and the Navy's Commonly Affordable Lightweight Fighter program.[4]

In September 1993, the BUR decided to cancel the MRF and A/F-X programs and develop technologies for a Joint Attack Fighter to replace the AV-8, F-16, and F-18 when they were to be retired in 2010. This effort became the Joint Advanced Strike Technology (JAST) program and its first director was appointed in December 1993. Initial JAST concept exploration contracts were awarded in May 1994 and these studies did not include a Marine Corps STOVL variant.[5]

Another noteworthy development in JAST evolution occurred in September 1994 when the DOD's Defense Science Board (DSB) issued a report on this program. This document focused on five key areas including: JAST program objectives, mission, and relationships; multi-service requirements; technology for affordability; risk assessment and reduction; and industry capabilities and motivations. DSB urged JAST to sharply focus on the following areas:

Table 4.1 JSF capabilities[3]

	F-35A	*F-35B STOVL*	*F-35C Carrier*
Length	51.4 ft.	51.2 ft.	51.5 ft.
Height	14.4 ft.	14.3 ft.	14.7 ft.
Wingspan	35 ft.	35 ft.	43 ft.
Horizontal tail span	22.5 ft.	21.8 ft.	26.3 ft.
Wing area	460 sq. ft.	460 sq. ft.	620 sq. ft./
Engine	F135-PW-100	F135-PW-600 with Lift fan	F135-PW-100
Thrust	25,000 lbs, 40,000 with afterburner	26,000 lbs, 38,000 with afterburner, 40,000 vertical with Lift fan	25,000 lbs, 40,000 with afterburner
Maximum speed, armed internally	Mach 1.6 at altitude	Mach 1.6 at altitude	Mach 1.6 at altitude
Maximum Gs in maneuver	9.0 g	7.0 g	7.5 g
Weight empty	29,300 lbs	32,300 lbs	34,800 lbs
Maximum weight	70,000 pound class	60,000 pound class	70,000 pound class
Internal fuel (IF)	18,250 lbs	13,500 lbs	19,750 lbs
Range	1200 nautical miles (nm)	900 nm	1200 nm
Combat radius	590 nm	450 nm	600 nm
Pre-installed	25 mm (GAU)-22/A+ 180 rounds, dorsal refueling	Refueling probe	Refueling probe
Standard internal weapons	2 × AIM-120C AmRAAM, 2 × 2000 lbs	2 × AIM-120 C AMRAAM, 2 × 1000 JDAM	2 × AIM-120C AMRAAM, 2 × 2000 lbs JDAM

(*continued*)

Table 4.1 (continued)

	F-35A	*F-35B STOVL*	*F-35C Carrier*
Initial weapons: F-35 Block 3F at end of system development and demonstration	AIM-9L/M/X Sidewinder air-to-air missile (external); AIM-120C7 AMRAAM BVR-AAM, GBU-12 Paveway II laser bomb 500 lbs, GBU-31 JDAM GPS bomb 2000 lbs, GBU-39 SDB-1 GPS glide bombs, 4 per slot (A), AGM-154 JSOW GPS/IIR glide bomb C; Terma 25 mm gun/220 rd. pod, convertible to other uses (C, external)	Terma 25 mm gun, 220 rd. pod (external); AIM-9L/M/X (external); AIM-120C7 AMRAAM; GBU-12; GBU-32 JDAM GPS bomb 1000 lbs; AIM-132 ASRAAM AA missile (UK); Paveway IV laser/GPS bomb, 500 lbs (UK)	Same as F-35A
Max. payload	18,000 lbs	15,000 lbs	18,000 lbs
Mission reliability	93%	95%	95%

- Service requirements for advanced strike systems within a defined end-to-end strike architecture;
- Affordable processes and end products;
- Transitioning technologies to form building blocks leading to engineering and manufacturing development (EMD);
- Demonstrating building blocks for high-confidence EMD programs;
- One or more advanced aircraft serving some combination of:
  - Carrier-based first-day-survivable stand-alone strike capability
  - Land-based sortie generation aircraft
  - Marine Corps multirole battlefield preparation
- The Office of the Secretary of Defense needing to continually ensure JAST is a technology customer and not a technology developer.[6]

DSB went on to contend new military aircraft requirements should include operating with minimum support in theater, operating in small formations or as a single aircraft with minimal or zero close escort or penetrating supporting elements, operating in high-threat areas with minimum attrition, and delivering precision weapons providing high lethality against various targets and also precluding unwanted collateral damage. This document went on to stress that the diverse and global nature of potential future challenges to US interests makes it critical that advanced strike capabilities include land- and sea-based options.[7]

In September 1995, Deputy Secretary of Defense John White directed Undersecretary of Defense for Acquisition and Technology Paul Kaminski to create a plan for developing a new aircraft from JAST. During a February 1996 meeting with military service secretaries, White approved the plan to develop a JSF. Contractors such as Lockheed Martin submitted proposals in June 1996 with Lockheed Martin proposing three JSF objectives:

1. Demonstrating it is possible to build a common CTOL, STOVL, and naval variants of a JSF;
2. Demonstrating STOVL performance and supersonic speed on the same flight; and
3. Demonstrating the handling qualities and carrier suitability of the naval variant since Lockheed Martin had never built a naval fighter.[8]

In May 1996 Kaminski changed JSF to an acquisition category 1D program and officially named it as JSF, instructing Congress that it was an aircraft development program. November 1996 saw Boeing and Lockheed Martin selected to build concept demonstration aircraft.[9]

Preliminary concerns about possible duplication and high costs were expressed early in JSF's history by the General Accounting Office (now Government Accountability Office) (GAO). A February 1997 GAO report expressed concern about overlapping air superiority capabilities in all armed services with particular emphasis on theater ballistic missile defense capabilities.[10] An additional and early factor driving enhanced and protracted program cost growth was a 1996 congressional decision establishing an alternate F136 engine developed by GE Transportation Aircraft Engines in Cincinnati and Rolls-Royce of Bristol, UK, with an auxiliary facility in Indianapolis. This was in addition to the JSF's primary F135 engine produced by Pratt & Whitney in East Hartford and Middletown, CT.[11]

Although JSF has been supported by Congress throughout most of its lifespan, concerns have regularly been voiced about the program. An early example of this concern was expressed by Senator Ted Stevens (R—AK) (1923–2010) who on March 4, 1998, commented that the JSF was moving into a costly phase which would produce substantial problems unless costs were restrained. However, Air Force Chief of Staff General Michael Ryan differed, stressing that JSF's role as a multirole aircraft made it less costly.[12]

During this same hearing Senator Kay Bailey Hutchison (R—TX) asked Ryan why both the F-22 and JSF were needed by the Air Force. Ryan responded that while the F-22 was a "force enabler" allowing a theater commander to rapidly achieve air superiority, the JSF would provide the preponderance of the Joint Commander's offensive airpower and support a mixture of dominance capability and high operational tempo enabling the Air Force to support its goal of full spectrum dominance. Senator Daniel Inouye (D—HI) (1924–2012) asked Ryan about the JSF's alternate engine, with Ryan saying the Air Force supported it even though there was no operational requirement for it and contended that it could provide additional benefits such as improved operational readiness since a single-engine problem would not ground the entire JSF fleet; provide improved contractor response due to competition; and enhance the US fighter engine industrial maintenance base. Ryan also maintained that this would cost an estimated $1.8 million.[13]

On March 17, 1999, Ryan, expressing concern about defense spending reductions and potentially emerging concerns with the JSF, told the same committee:

> I must tell you, though, that I am becoming more and more worried about the future and our ability to pay for some of the systems that we believe you need and Congress has already authorized. We want to upgrade our missile warning capability. And further, we have anxiety about the future of the Joint Strike Fighter (JSF).[14]

Despite Ryan's anxiety about JSF, he responded to a question during this same hearing by Senator Byron Dorgan (D—ND) on possible delays to the JSF, by asserting that the JSF was on track to replace aging F-16 and A-10 fleets beginning in FY 2008. At the same time, the Congressional Budget Office (CBO) released a report saying the cost of future DOD plans to buy 2852 JSF, 339 F-22s, and 548 F-A/18-E/Fs would approach $340 billion. Such inconsistent program delivery and pricing predictions would become JSF hallmark characteristics.[15]

The JSF's technological complexity was described during a December 7, 1999, hearing held by the House Government Reform Committee's National Security Subcommittee. Testifying before this panel Darleen Druyun, the Principal Deputy Assistant Secretary of the Air Force for Acquisition and Management, said that the F-22's avionics system had 2.2 million lines of code and mentioned that the JSF's avionics system was even more complex and that its lines of code could double the F-22's depending on the individual contractor's design.[16]

In March 2000, CBO recommended that slowing JSF's purchase by two years would reduce development and production requirements by $3 billion over the next five years and $22.3 billion through 2010.[17] In the same month GAO expressed further concern about JSF acquisition during congressional testimony. Specific concerns expressed by this agency include critical technologies being projected at low technical maturity levels when engineering and manufacturing development contracts are scheduled to be awarded and that when competing contractors experienced design problems and cost overruns, and DOD restructuring, the program would provide less information than originally planned before selecting between competing contractor proposals.[18]

GAO consequently recommended that the Secretary of Defense direct the JSF Program Office to adjust the planned March 2001 engineering and manufacturing development decision date to allow sufficient time for critical technologies to mature before awarding the engineering and manufacturing development contract.[19]

2000s

JSF has experienced significant successes and setbacks during the twenty-first century. On October 24, 2000, its X-35A prototype completed its first test flight at Palmdale Regional Airport, CA; November 22, 2000, saw it complete its flight program and return to Palmdale as the X-35B, and on December 16, 2000, the X-35C prototype completed its first test flight from Palmdale to Edwards AFB, CA. May 24, 2001, saw operations begin on the X-35B flight ready system; June 23, 2001, saw the X-35B achieve the first press-up representing the first time a shaft-driven lift-fan propulsion system lifted an aircraft; and on August 6, 2001, the X-35B completed its flight testing with its 66th test flight.[20]

Contract Awarded

On October 26, 2001, the DOD awarded the JSF's System Design and Development Contract to Lockheed Martin along with Northrop Grumman and BAE systems. The award was announced by Under Secretary of Defense for Acquisitions, Technology, and Logistics Edward Aldridge; Secretaries of the Air Force and Navy James Roche and Gordon England; British Minister of Defense Procurement Lord Willy Bach; and Sir Robert Walmsley, the United Kingdom's National Armaments Director and Chief of Defense Procurement. They announced that the review process involved nearly 250 individuals, mentioned the JSF would be produced in CTOL for the Air Force, a carrier variant for the Navy, and a STOVL variant for the Marine Corps and the United Kingdom. The estimated value of this contract, in terms of international participation, was said to exceed $200 billion. As envisioned during this announcement, JSF was said to begin operations in 2008, last until 2040, and be able to bring US fighter forces to almost all-stealth status by 2025.[21]

Specific contractual details saw Lockheed Martin receive an $18,981,928,201 billion cost-plus-award-fee for JSF's Engineering and Manufacturing Development Program. Sixty-six percent of the work was to be performed in Fort Worth, TX; 20% in El Segundo, CA; and 14% in Warton/Samlesbury, UK, with April 2012 listed as the targeted completion date. Pratt & Whitney Military Engines in East Hartford, CT, received a $4,803,460,088 cost-plus-fee-award contract for designing, developing, fabricating, and testing the F135 engine propulsion system and common hardware to complete ground testing and demonstrate conformity with testing requirements. Seventy-two percent of this work was to be performed in East Hartford, CT; 16% in Middletown, CT; 1% in West Palm Beach, FL; and 11% by Rolls-Royce as a UK subcontractor, with April 2012 as the targeted completion date.[22]

Manufacturing began on the F-35 airframe with milling processes on November 10, 2003, and the first F-35 left the Lockheed Martin factory on February 20, 2006.[23] Awarding this contract and these initial technical accomplishments did not stop Congress and congressional support agencies like GAO from closely scrutinizing JSF's performance and expressing concern about program progress during the first term of George W. Bush's presidency.

In an October 24, 2001, hearing on the Bush Administration's just-released *Quadrennial Defense Review* (*QDR*) Senator Rick Santorum (R—PA) asked Deputy Secretary of Defense Paul Wolfowitz how the JSF would address anti-access and power projection threats facing the military. Wolfowitz replied that the JSF would complement existing power projection capabilities and be a critical enabler in countering anti-access threats such as SAMs, fighters, cruise missiles, theater ballistic missiles, and weapons of mass destruction.[24]

The hope that the international collaboration involved with the JSF would lead to positive cost benefits was expressed by Undersecretary Douglas Feith when he told the Senate Armed Services Committee on February 28, 2002, that "The Joint Strike Fighter is a model of cooperation and efficiency involving the United States and several allies."[25] Efforts to give small businesses a stake in JSF contracting and to extend the program's geographic economic and political impact were reflected in Undersecretary of Defense Aldridge's May 15, 2002, comments that small businesses could get 20–30% of JSF funding.[26]

Grassroots concern about the potential financial costs of the JSF and whether the F/A-22 fighter was necessary and relevant was expressed by Steve Ellis, the Vice-President of Taxpayers for Common Sense, during the April 11, 2003, congressional testimony on tactical aircraft programs.[27] Concern that the international collaboration involved in the JSF might not be as productive as intended was expressed by Rep. Michael Turner (R—OH) in a July 21, 2003, hearing: "The Joint Strike Fighter [JSF], could be a model for twenty-first century system acquisition, promising three-planes-in-one jointness, and unprecedented international cooperation. Or it could fall prey to the same cost growth, schedule delays, and inter-service disputes that plagued so many cold war procurements."[28]

At this time, GAO released a report on the JSF's international cooperation elements and relevant strengths and weaknesses involved. Report findings indicate that while international partners can share future program costs increases that they are NOT required to do so; that if program costs increase the burdens will fall nearly entirely on the United States; that technology transfer matters present major challenges for program participants; that increased pressure to approve export authorizations supporting program goals could produce unintended consequences including inadequate license content reviews or broad interpretations of disclosure authority; and that extending necessary technology transfers to achieve program commonality involving aircraft commonality could stretch US disclosure policy for the most sensitive military technology. GAO also announced that if return-on-investment expectations are not met in partner company countries then JSF could lose domestic political support; that Lockheed Martin needs to ensure a level playing field for foreign companies and their subcontractors; and that the DOD needs sufficient information about foreign contractors to ensure they meet cost and schedule requirements.[29]

During a February 4, 2004, exchange with Senator Saxby Chambliss (R—GA), Secretary of Defense Donald Rumsfeld acknowledged that the JSF has a weight problem in response to Chambliss' concern that it could be a "train wreck" where tactical airpower capabilities were concerned and expressed hope that JSF weight problems could be resolved.[30] Responding to a March 24, 2004, questioning from Senator Thad Cochran (R—MS) on the JSF's weight problem, Roche stressed he did not think weight was a terminal problem, but because it affects the STOVL the Air Force thinks it is responsible to devote attention to reducing STOVL risk. He also added that if weight could be reduced then more engine thrust could be produced consequently enhancing weapons system effectiveness.[31]

The second term of the George W. Bush Administration saw increasing recognition of the complexities, political tensions, and costs involved in defense International Armament Cooperative Programs (IACP) which JSF proponents have heralded as spreading cost burdens more equitably. A 2006 Air University study on IACP found that such partnerships can strengthen alliances, reduce acquisition costs and increase market share for US industry, bolster domestic and allied industrial bases, and increase coalition capability. Detrimental aspects of IACP include the risk of partner defection, undue risks assumed by the lead country, invigorating industrial competitors, limiting coalition warfare capabilities, running the risk of countries "going rogue" as demonstrated by the 1978–1979

Iranian Revolution resulting in the Islamist regime gaining possession of previously delivered F-14 Tomcats, and the possibility of partner countries using technology acquired through IACP participation for reverse engineering purposes injurious to the defense and economic interests of participating countries.[32]

Recommendations for policymakers embarking on IACP by Stephen DiDomenico include:

- Approaching critical technologies' export decisions at the capabilities level. Include timeframe when capability-enabling technologies will be delivered and to whom they will be delivered. Protect critical technologies with anti-tamper and logistics/depot agreements.
- Consolidate policy interagency process within Commerce, DOD, and State to ensure the United States speaks with one voice before supporting or opposing an IACP.
- Remove international cooperative process impediments such as the Buy American Act.
- Relax technology transfer and export controls to take advantage of global market environment. Recognize completion fosters lower cost and defense product innovations.
- Expedite slow and inefficient export approval by consolidating disparate National Disclosure Policy Committee and other export committees within the DOD into a one-stop shop for vetting national disclosure policy exceptions.
- After international buy-in and financial commitment, protect program from bill-paying practices tending to push content to the right to save money but increasing long-term program costs.[33]

Recommendations for IACP program managers include:

- Do not embark on an IACP without full support from political and military leadership.
- Establish a streamlined interagency panel process with an empowered voting body to quickly adjudicate problems.
- Decide up front what "crown jewels" US capabilities will and will not be given up. Ensure capabilities are vetted by the entire non-disclosure committee before beginning development. Ensure participants are empowered to make decisions and provide frequent insight to these communities during development as technologies enable capabilities to become more refined.

- Communicate expectations to partners clearly and early to prevent future acrimony or possible defection. Ensure agreements are specifically documented in Memorandums of Understanding (MOU). Include in MOUs cost-sharing conditions and responsibilities when costs escalate. Do not make or imply promises you have no authority for.[34]

Nunn-McCurdy Breaches

Recognizing the tendency of defense acquisition programs to experience cost overruns, Congress established the Selected Acquisition Report (SAR) as a program performance gauge and legal reporting requirement in 1975.[35] In 1981 Senator Sam Nunn (D—GA) and Rep. David McCurdy (D—OK) introduced what became known as the Nunn-McCurdy amendment to 1982 defense spending legislation. Nunn-McCurdy established congressional oversight of defense acquisition weapons systems whose costs increased beyond certain limits. Two unit costs were defined in this legislation with the first being the Program Acquisition Unit Cost (PAUC) consisting of development cost, procurement cost, and system-specific military acquisition program construction, divided by the number of fully configured end items slated to be produced for the acquisition program. The second unit cost is the Average Procurement Unit Cost (APUC) which is government funding divided by the number of units procured. Weapons system cost growth was measured by how much 1982 unit costs exceeded the same unit costs reported in the March 31, 1981, SAR.[36]

Nunn-McCurdy became permanent with the 1983 defense authorization legislation requiring the Secretary of Defense to tell Congress when a major weapons systems cost growth exceeded 15%. If cost growth surpassed 25%, the program was assumed terminated unless the Secretary of Defense made a written declaration to Congress that a breach occurred.[37] The 2006 Defense Authorization Act changed Nunn-McCurdy reporting requirements to include the original baseline as a benchmark to measure cost growth against.[38]

The Bush Administration's second term saw continued legislative wrangling and debate over the JSF's continued funding, cost growth, and program performance. Despite legislative concerns, program funding remained on course. There was also debate over whether the JSF was necessary given the emergence of unmanned military aircraft and uncertainty over military aircraft from hostile countries threatened current US military airpower. This sentiment was expressed by Brookings Institution defense analyst Michael O'Hanlon on February 16, 2005, in testimony before the House Budget Committee when he maintained: "We are going to provide 2500 manned airplanes in an era when unmanned airplanes are becoming more and more effective and when our current generation airplanes are not seriously at risk from most of the enemies that we are facing today." He went on to advocate that the DOD should buy additional F-16s, purchase approximately 1000 JSF, and remove the Navy from the JSF program.[39]

Dissatisfaction with JSF from other federal agencies was expressed in a March 29, 2006, House Armed Services Committee hearing by Missile Defense Agency Acquisition Advisor Terry Little. He maintained that the 1990 Defense Acquisition Workforce Improvement Act, requiring the DOD to establish education, training, and requirements courses for civilian and military acquisition workers, had to many holes allowing for waivers and deviations, complained about the large numbers of JSF program managers during its existence, and contended that program managers should be given a maximum of five years to produce results before leaving.[40]

GAO Program Milestones 2005–2008

On December 15, 2006, the JSF Lightning II made its first flight; on June 11, 2008, the JSF B made its first flight; on November 13, 2008, the JSF made its first supersonic flight, and in-flight integration of JSF avionics occurred on November 24, 2008.[41] Program accomplishments and problems were noted in GAO reports and in congressional committee hearings during this period. A March 2005 GAO report found that program acquisition costs have increased by $19 million or 23% since 2001; that warfighter delivery had been delayed for two years; that the full impact of recent aircraft design changes may not be known for some time; and that the Air Force, Marines, and Navy have not determined how many aircraft they will buy. This assessment went on to add that the DOD would find it difficult to deliver on future business case agreements if program accountability continues being compromised by frequent program management changes. This report also asserted that its monthly production, facilities, and tooling spending went from $100 million per month in 2007 to $1 billion a month in 2013 before flight testing is completed.[42]

Another GAO report that month determined that JSF program unit costs went from $64.048 billion in September 2001 to $80.840 billion in December 2003 for a 26.2% increase while planned aircraft purchases fell from 14.3% from 2866 to 2467.[43] One year later GAO determined that the DOD planned to begin low-rate initial JSF production in 2007 with inadequate testing to prove a mature design for the three basic airframe variants, without developing critical software, or without a fully integrated aircraft with advanced missions systems and prognostic maintenance capabilities. The report went on to add that the three variants will not start flight testing until 2009; that a fully configured integrated development will not begin flight testing until 2011—four years after production begins; that the DOD plans to have ordered 190 aircraft at a cost of $26 billion in 2011; and that in 2013 the JSF program plans to have purchased 424 aircraft for an expected $49 billion cost. However, these purchases will occur using cost-reimbursable contracts because the DOD lacks necessary design, performance, and technology knowledge, placing increased risk on the DOD. GAO subsequently recommended that the DOD delay production investments and production in JSF production capability until aircraft design qualities and integrated mission capabilities of fully configured and integrated variants are proven to work in flight testing.[44]

March 2007 saw GAO note that the JSF delivered and flew its first developmental aircraft and started manufacturing additional development aircraft for its test program. It also noted program costs had increased $31.6 billion since 2004 and that late design drawings, design and manufacturing processes changes, and late subsystem deliveries have produced delays preventing timely manufacturing and delivery of development aircraft. GAO recommended that the Secretary of Defense limit annual JSF production to 24 until each variant's basic flying qualities have been demonstrated in flight testing scheduled for 2010.[45]

Testifying before the House Armed Services Committee's Subcommittees on Air and Land Forces and Seapower and Expeditionary Forces on March 22, 2007, GAO Director of Acquisition and Sourcing Management Michael Sullivan reported on findings concerning JSF's previously authorized alternate engine. Sullivan mentioned that continuing with the alternate engine could cost significantly more than a sole-source engine but could produce costs and other benefits in the long run. The estimated life cycle cost for a sole-source engine is $53.4 billion and an additional $3.6–$4.5 billion could be required to implement the alternate engine program. Sullivan asserted that associated competitive pressures from the alternate engine could produce 10.3–12.3% savings that could recover that investment and bring non-financial benefits such as better engine performance and reliability, improved industrial base stability, and more responsive contractors.[46]

Despite this qualified GAO support for the alternate engine program, it was not favored by the military. William Balderson, Deputy Assistant Secretary for Naval Air Programs in the Navy Department, told Rep. Neil Abercrombie (D—HI) that the DOD's decision to cancel this program was based on affordability and that expected savings from competition did not outweigh the investment costs. However, the alternate engine remained in the JSF until it was canceled by General Electric and Rolls-Royce on December 2, 2011.[47]

A March 6, 2008, congressional hearing on proposed 2009 defense spending legislation saw continued concern about the JSF's alternate engine expressed in the following exchange between Rep. Gene Taylor (D—MS) and Secretary of the Navy Donald Winter:

> **Taylor**: Given that the Pratt-Whitney F-135, short-takeoff, vertical landing development engine has experience two failures during testing, do you think it would be prudent to continue the Joint Strike Fighter's competitive engine program that was mandated in last year's Defense Authorization Act but not provided any funding for the Department of Defense?
>
> **Winter**: Sir I believe that the problems that have occurred with the 135 engine, the Pratt engine, are not atypical, if you will, for a development of this caliber. And we do believe that they are understood and they are good plans in place right now to provide the corrective remedies that will enable us to use that engine appropriately for testing.
>
> I would note that for the Department of the Navy, both the Marine Corps and the carrier Navy, we do have a particular issue in terms of being able—having to go down to a single-engine type for our fleet. The challenges of maintaining and sustaining those engines at sea are such that we cannot provide for multiple engine support onboard either our big deck amphibs or our carriers.[48]

Visible frustration with exponentially rising JSF costs was expressed on March 12, 2008, by Rep. Jim Moran (D—VA) in a House Appropriations Committee Defense Subcommittee hearing. Moran complained about program expenses reaching $1 trillion, that total acquisition costs had increased by $23 billion due to higher procurement costs, and noted GAO commenting that $288 billion spent for acquisition was unreliable due to insufficient documentation. Moran also expressed displeasure that GAO had found three independent defense offices had concluded that program costs estimates were understated by $38 billion and that aircraft delivery schedule was going to slip two years. He concluded his criticisms to

Secretary Winter by asking why the United States was investing in a Cold War aircraft instead of dealing with terrorist groups that will not seek to challenge US air superiority.

Winter responded that the JSF was intended to give the United States the ability to respond to current and emerging threats; stressed its power projection capabilities to ground and naval forces, noted the importance of being able to project power from the sea; emphasized the Navy would not place orders for production until sufficient flight test evaluation has occurred; and that the first STOVL flight was anticipated to occur later in 2008.[49]

The JSF's technical complexity is characterized by its 22.9 million software source code lines which are dwarfed by the 95.1 million lines of software source code in the Army's Future Combat System (FCS) program which has also experienced controversy.[50] A March 2008 GAO report noted that recent DOD JSF decisions added to program risk. Examples of these decisions include DOD deciding not to request funding for the alternate engine program in an attempt to increase management reserves from $400 million to $1 billion which GAO maintained significantly increased the risk of not completing development testing on time, and not fixing design and performance problems until late into operational testing and development when it is more expensive and disruptive. GAO also maintained that DOD's Mid-Course Risk Reduction Plan does not directly address or correct ongoing production and schedule concerns that depleted management reserves; that its expectation that program development and procurement costs increase substantially and that schedule pressures will worsen based on existing performance and conditions; that two-thirds of JSF budgeted funding have been spent on the prime development contract with only half the work being completed; and that program cost estimate standards remain unreliable when compared with federal government and industry cost estimate standards.[51]

This assessment also noted the following use of $1.4 billion in JSF management reserves by the DOD between 2004 and 2007 (Table 4.2).

Manufacturing delays were also noted by GAO (Table 4.3).

Table 4.2 JSF management reserves 2004–2007[52]

$430 million—Engineering drawings	29%
$370 million—Supplier design and performance	25%
$350 million—Production products and labor	24%
$163 million—Other	11%
$160 million—Weight and technical changes	11%

Table 4.3 JSF manufacturing delays[53]

Development aircraft	*Forward fuselage*		*Wing*		*Final assembly*	
	Days behind	*Cost efficiency (%)*	*Days behind*	*Cost efficiency (%)*	*Days behind*	*Cost efficiency (%)*
STOVL-1	In mate	119	In mate	69	–	77
STOVL-2	−19	148	−129	65	–	–
STOVL-3	−34	133	−134	49	–	–
STOVL-4	−68	115	−162	23	–	–
CTOL-1	−73	139	−279	23	–	–
CTOL-2	−35	78	−283	–	–	–
CTOL-3	−35	58	−140	–	–	–

Rand Report Controversy

Controversial programs such as the JSF can attract media attention from US and international sources. This was true in 2008 when the Australian Broadcasting Corporation program *Lateline* published a story claiming that an August 2008 war game simulation by the Rand Corporation (a prominent federally funded research and development center) determined that a large Chinese air and naval assault against Taiwan decimated Taiwanese and US military forces including the JSF.[54]

This claim was debunked by Rand in a September 25, 2008, statement by that organization's Project Air Force Director Andrew Hoehn who maintained:

> Recently, articles have appeared in the Australian press with assertions regarding a war game in which analysts from the RAND Corporation were involved. Those reports are not accurate. RAND did not present any analysis at the war game relating to the performance of the F-35 Joint Strike Fighter, nor did the game attempt detailed adjudication of air-to-air combat. Neither the game nor the assessments by RAND in support of the game undertook any comparison of the fighting qualities of particular fighter aircraft.[55]

JSF Program Milestones 2009–2012

The Obama Administration's advent in 2009 saw additional milestones reached by JSF along with continuing delays and controversy. On March 18, 2010, the F-35B made its first vertical landing at Patuxent Naval Air

Station in Maryland. June 6, 2010, witnessed the first naval carrier variant flight. The first flight of the first production of the F-35 AF-6 occurred on February 25, 2011, the System Development and Demonstration (SDD) F-35 fleet surpassed 1000 flight hours on April 6, 2011, and the Air Force accepted the first low-rate initial production into its inventory on May 5, 2011. On July 14, 2011, Lockheed Martin delivered the first F-35 to Eglin Air Force Base, FL, for pilot and maintainer training; on July 27, 2011, a catapult launched the F-35C for the first time at Joint Base McGuire-Dix-Lakehurst, NJ; October 3, 2011, saw the F-35B land on the USS *Wasp* in JSF's first vertical landing on a ship; the first F-35B was delivered to the Marine Corps on January 11, 2012; the first international F-35 was delivered to the United Kingdom on July 12, 2012; and on November 20, 2012, the first three F-35s were delivered to the Marine Corps Air Station in Yuma, AZ making this the first operational JSF base.[56]

Weapons Systems Acquisition Reform Act

Continuing congressional concern with the high price of JSF and other defense weapons systems led Congress to enact the Weapons Systems Acquisition Reform Act (WSARA) in 2009. This legislation received broad bipartisan approval with Senator Carl Levin (D—MO) noting on May 6, 2009, that commonality between the JSF's three variants would reduce cost and that three of JSF's eight critical technologies are still not mature. Senator John McCain (R—AZ) 2009 contended that WSARA was justified by the JSF program being "completely out of control" and noting contracts lose touch with original estimates and realities.[57]

WSARA provisions included:

1. Requiring the DOD to designate officials to serve within the Office of the Secretary of Defense (OSD) as principal advisors on acquisition functions involving cost estimation, systems engineering, and performance assessment.
2. Encouraging the DOD to conduct technology readiness estimates and expand use of independent cost estimates early in the acquisition process.
3. Requiring the DOD to ensure that acquisition strategies for Major Defense Acquisition Programs (MDAP) include measures ensuring competition, or the option of competition, at both prime contract and subcontractor levels throughout each program's lifecycle.

4. Requiring the DOD to carry out a program recognizing performance excellence by individuals, armed forces team members, and civilian personnel in acquiring products and services.[58]

A December 2012 GAO report on WSARA acknowledged evidence of more realistic JSF program cost estimates, mentioned the DOD had implemented most fundamental reform act provisions, was strengthening acquisition activities, and contended WSARA was helping identify programs and mitigating risks earlier in the acquisition process. It also noted remaining problems include organization capability constraints making it difficult to expand WSARA's impact; that military services would like more cost estimation and implementation guidance; that these services may not have sufficient resources to oversee and conduct systems engineering and developmental testing activities; that expanding use of lessons learned would enhance impact across the acquisition portfolio; and that systemic change will be difficult until cultural barriers are addressed. Examples of these cultural barriers include relationships between military services and OSD and concerns by service officials that OSD regulations are burdensome.[59]

The FY 2010 Defense Authorization Act included $6 billion for the Obama Administration's requested purchase of 30 JSF with 10 of these for the Air Force and 20 for the Navy. In addition, Congress included an additional $2 billion for research and development which was $215 million more than the administration's request. This legislation also mandated that GAO present annual reports on JSF program performance through 2016.[60]

CBO Fighter Modernization Study

Purchasing JSF, retaining existing fighter fleets, increasing reliance on UAVs, or some combination of these weapons systems are all options facing US civilian and military policymakers. A May 2009 CBO report discussed fiscal and operational consequences of new fighter aircraft under DOD's FY 2009 modernization plans and alternatives which would satisfy military inventory requirements. Alternative 1 satisfying inventory requirements by accelerating/increasing JSF purchases was estimated to cost $59 billion between 2010 and 2014 and $157 billion between 2010 and 2034. Alternative 2 involving satisfying inventory requirements by purchasing JSF's and improving legacy aircraft would cost $64 billion between 2010 and 2014 and $160 billion between 2010 and 2034. Alternative 3 involving canceling JSF and purchasing improved legacy aircraft would cost $39 billion between 2010 and 2014 and $117 billion between 2010 and 2034. Alternative 4 covering purchasing JSF in quantities matching 2009 weapons capacity would cost $48 billion between 2010 and 2014 and $105 billion between 2010 and 2034. Alternative 5 covering purchasing enough JSF to match 2009 weapons capacity and purchasing small armed UAVs to meet inventory requirements would cost $51 billion between 2010 and 2014 and $119 billion between 2010 and 2034. Alternative 6 involving replacing some fighter aircraft with medium-range bombers or UAVs to improve mission range would cost $58 billion between 2010 and 2014 and $153 billion between 2010 and 2034. Finally, Alternative 7 involves replacing some fighter aircraft with medium-range bombers or UAVs to improve mission range and augmenting fleets with small armed UAVs to satisfy inventory requirements would cost $61 billion between 2010 and 2014 and $165 billion between 2010 and 2034.[61]

Nunn-McCurdy Breach

On March 20, 2010, Secretary of Defense Robert Gates announced that the JSF had exceeded the cost containment limits specified in Nunn-McCurdy with JSF's average procurement costs in FY 2002 dollars growing 57–89% over the original program baseline. This breach was reported to Congress with specific cost breaches totaling 78.23% for the PAUC and 80.66% for the APUC. A few weeks earlier, Defense Acquisition head Ashton Carter issued a memorandum restricting the JSF with highlights of this restructuring including:

- Extending the SDD phase by 13 months and delaying full-rate production to November 2015 and adding extra low-rate initial production aircraft to be purchased during the delay.
- Withholding $164 million in contractor award fees for poor performance and adding incentives to produce more aircraft than planned with the new budget.
- Moving procurement funds to R&D. More than $2.8 billion previously budgeted to buy JSF could be used to continue program development.[62]

On January 6, 2011, Gates announced changes in JSF testing and production plan focusing on the F-35B. Noting that the Air Force and Navy versions are proceeding satisfactorily, Gates noted the Marine Corps STOVL version was experiencing significant testing problems that could produce a redesign of aircraft structure and propulsion which could add more weight and cost to an aircraft which is incapable of absorbing these two factors. He went on to place the STOVL on two-year probation; stated that if this program did not get back on cost, performance, and schedule then it would be canceled; and that it would move to the end of JSF's production sequence. Specific technical problems with this aircraft included premature wear on hinges for an in-door feeding its lift fan, cracks discovered in a bulkhead used for fatigue testing following 1500 hours of flight time out of a planned total of 16,000 hours, and the need to redesign the driveshaft, lift-fan clutch, actuator for the roll-post nozzles after discovering that the driveshaft contracts and expands more than expected and that other components experience more heat than anticipated during flight operations.[63]

Secretary of Defense Leon Panetta lifted the JSF's STOVL variant from probation in a January 20, 2012, announcement at Maryland's Patuxent Naval Air Station, saying: "Over the course of the last year, you here at Pax River have made an incredible difference by completing tremendous amounts of STOVL testing. … You've demonstrated that we have made real progress toward fixing some of the known problems that we have had with STOVL." Panetta went on to mention that there was still more work to be done with the JSF.[64]

Sequestration

Concerns over the rising federal budget deficit and national debt and increased calls for significant cuts in federal spending led Congress in 2011 to establish a Joint Select Committee on Deficit Reduction. A draft document prepared by the chairs of the Simpson-Bowles fiscal commission on November 12, 2010, called for using F-16 and F/A-18Es for half of the Air Force's and Navy's planned JSF purchases which commission leaders claimed would produce savings of $9.5 billion between FY 2011 and FY 2015.[65] An option considered by this committee was sequestration involving automatic across-the-board spending cuts for government programs with some exceptions. The 2011 Budget Control Act included sequestration designed to last ten years for discretionary budget expenditures including defense spending.[66]

On November 15, 2011, Panetta warned that if sequestration began in January 2013 then it would add $500–$600 billion in DOD spending reductions in addition to already planned reductions of $450 billion over the next ten years. He asserted that sequestration would mean termination of the JSF and of the next-generation bomber, intercontinental ballistic missile, missile defense, and upgrades to existing programs.[67]

On April 24, 2013, JSF Program head Air Force Lt. General Christopher Bogdan told the Senate Armed Services Committee that sequestration has the potential either to stretch the development program out or to reduce the capabilities warfighters can get. He claimed sequestration cuts funds for the program, meaning development will be stretched out, causing the program to cost more in the long run. This will have impacts on international partners. Cost increases may result in reduction of their aircraft quantities which would, in turn, increase unit costs even more and cause them to relook their commitment to the program. Furloughs of civilian workers will have immediate negative consequences including causing a reduction in testing and potentially reduce productivity by a third.[68]

Subsequent JSF Funding

A 2012 defense spending legislation saw Congress include language requiring the DOD to engage in fixed-price contracting for JSF and requiring Lockheed Martin to assume full responsibility for costs under the contract above the targeted cost specified in the contract. It also included $9.4 billion for F-35 research and procurement.[69] A 2013 defense spending legislation saw Congress appropriate $1.007 billion for the carrier variant and $1.482 billion for SDD.[70] The 2014 defense spending bill saw JSF's carrier variant receive $1.135 billion, the STOVL variant receive $1.267 billion, and $1.036 billion in research, development, test, and evaluation funding.[71] For FY 2015, Congress granted JSF $610,000 for the carrier variant and $1.029 billion research, development, testing, and evaluation. Section 153 of this legislation saw Congress require GAO to submit an annual report reviewing JSF acquisition containing the following information:

- The extent to which this acquisition program is meeting cost, schedule, and performance goals.
- Progress and results of developmental and operational testing.
- Progress of F-35 procurement and manufacturing.
- Assessment of plans and efforts by the Secretary of Defense to improve the efficiency of F-35 procurement and manufacturing[72]

In its FY 2016 congressional budget request unveiled on February 2, 2015, the DOD requested $10.6 billion to purchase 57 JSF with 44 of these being the CTOL variant for the Air Force, 9 the Marine Corps STOVL version, and 4 the Navy's carrier version. These requests received consideration during spring 2015.[73]

Additional Congressional JSF Oversight

Scrutinizing JSF program accomplishments and setbacks remains an ongoing chore for congressional oversight committees. Testifying before the House Natural Resources Committee on March 24, 2011, American Resources Policy Network President Daniel McGroarty noted that the rare earth element rhenium provides high-performance jet engines for aircraft such as the JSF and that it is prized for its ability to retain its strength, shape, and conductive properties at extremely high temperatures. McGroarty went on to mention that the United States imports 86% of its rhenium from China and Kazakhstan and that it could be extracted from domestic copper and molybdenum mining resources.[74]

The capabilities of some weapons systems are classified and not publicly available in hearing transcripts or other publicly accessible documents. An example of this is reflected in the following question submitted to Pacific Command Commander Admiral Robert F. Willard from Senator Kelly Ayotte (R—NH) on February 28, 2012. "In light of the development of the Chinese development of their own advanced fighter, DOD has certified that there are no suitable alternatives to the F-35 JSF. How critical is the JSF to protecting U.S. interests and maintaining U.S. air dominance around the world but more specifically in the Asia-Pacific region?" Admiral Willard did not provide a response to this question in the hearing transcript.[75]

On April 11, 2013, Secretary of Defense Chuck Hagel told the House Armed Services Committee that the DOD was continually taking steps to tighten contract terms and reduce risk in the JSF.[76] Testifying before the Senate Appropriations Committee's Defense Subcommittee on June 19, 2013, Chief of Naval Operations (CNO) Jonathan W. Greenert sought to emphasize the importance of the JSF's stealth capability to subcommittee members:

> Now, with regard to capability, we need the stealth. We need their advanced electronic warfare (EW) sensors, the weapons, and perhaps more importantly, the command and control capability that this aircraft brings. With its stealth and its EW capability, it effectively enables us to be closer to the

> threat. You can fuse targets. That means as you detect targets, you can bring them together, determine what is what, what is the threat, and build a common operational picture, and you can engage first. And perhaps just as important, the F-35 Charlie is designed to share this operational picture with other F-35s, other tactical aircraft, including our Super Hornet and the other aircraft in the air wing, other ships, other platforms via our tactical data links. So it really is a force multiplier in addition to be an incredibly capable aircraft.[77]

Later during this hearing Air Force Chief of Staff General Mark A. Welsh III told the appropriators that the following adversary technological developments and aging US fighter fleet make the JSF necessary with the following declaration:

> I believe the F-35 is essential to ensuring we can provide that air superiority in the future. Potential adversaries are acquiring fighters on par with or better than our legacy fourth-generation fleet. They are developing sophisticated early warning radar systems and employing better surface-to-air missile systems, and this is at a time when our fighter fleet numbers about 2000 aircraft and averages a little over 23 years of age, the smallest and the oldest in the Air Force's history. America needs the F-35 to stay a step ahead, to make sure that the future fight is an away game and to minimize the risk to our ground forces when conflict inevitably does occur. Its interoperability among the Services and partner nations, its survivability against the advance integrated air defense systems, and its ability to hold any target at risk make the F-35 the only real viable option I see to form the backbone of our future fighter fleet.[78]

Marine Corps Assistant Commandant John M. Paxton, Jr. stressed that the F-35B STOVLs triple the number of global airfields that can be used, and combined with the F-35C carrier variant doubles the number of US capital ships capable of operating a fifth-generation multirole fighter. Paxton went on to contend that in the emerging international security environment of anti-access and aerial denial technology, along with the ability of state and non-state actors, to reach out and touch surface targets thousands of miles out at sea requires the United States to have sufficient assets to counter such threats.[79]

Responding to a question from Senator Jack Reed (D—RI), Undersecretary of Defense for Acquisition, Technology and Logistics Frank Kendall said he was "reasonably confident" that JSF classified information was being protected from hostile cyber threats. Kendall also told Senator Richard Shelby

(R—AL) that the JSF was an affordable program and mentioned the progress made in resolving software problems. Subcommittee Chair Senator Richard Durbin (D—IL) asked Kendall if the JSF was “too big to fail” with Kendall responding he did not think any DOD program was “too big to fail” as a matter of principle and that DOD was not at a place where it would consider terminating the JSF.[80]

A 2013 DOD *Strategic Choice and Management Review* recommended trading away size for high-end capability while advocating that the DOD budget protect investments to counter anti-access and aerial denial threats such as the JSF, long-range strike systems, and cruise missile submarines.[81]

Concern over the possible export of stealth technology by countries such as Russia and China was expressed by Rep. Kay Granger (R—TX) in a March 13, 2014, House Appropriations Committee hearing to Secretary Hagel, who responded by saying that the United States intended to retain its technological edge over its adversaries and that the JSF is a key example of US intent in this area. During a March 25, 2014, hearing before this committee CNO Admiral Jonathan Greenert told Rep. Steve Womack (R—AR) that the JSF-C version would deploy to the Western Pacific in 2019–2020.[82]

A March 26, 2014, House Armed Services Committee hearing expressed concern about recent JSF software problems with Reps. Jim Turner (R—OH) and Loretta Sanchez (D—CA) also expressing concerns about JSF cost management. Testifying before the committee JSF Program Director Bogdan thanked the committee for its support for the JSF through its troubles and said the program was making slow and steady progress in technical improvements and cost management. He also asserted:

> I believe the F-35 program is headed in the right direction now, and I am confident in our ability to meet U.S. Marine Corps initial operating capability and Air Force initial operating capability in the summers of 2015 and 2016, respectively, with all the capabilities our warfighters need. We are now seeing the benefits of a disciplined systems engineering process that we instituted a few years ago in response to many of our technical issues, including improvements on the helmet, the hook, our fuel dump capability, weapons capability, lightning protection, and night and all-weather flying. We are closely managing F-35 onboard and off-board software, and software still remains the number one risk on the program. We have also fundamentally changed the ALIS system, our [Automatic Logistics Information System], and are starting to see some incremental improvements there.

> We are also fully committed to making the F-35 more affordable in both the cost of buying the airplanes and the cost of operating and sustaining the aircraft.[83]

During an April 2, 2014, Senate Appropriations Committee hearing Senator Dan Coats (R—IN) asked Air Force Secretary Deborah Lee James whether upgrading F-16 aircraft to include service life extensions would ensure fighter wings with these aircraft would be able to compete for the JSF in the future and when would the next Air National Guard JSF base be chosen. James responded by saying that F-16s would have a sustained service life for peacetime and combat activities and that the next round of F-35A basing would begin in 2016–2017.[84]

Testifying before the Senate Armed Services Committee on March 12, 2015, US Northern Command Commander Admiral William E. Gortney noted that during 2014 Russian heavy bombers flew more out-of-area patrols than any year since the Cold War. Gortney went on to note improved interoperability between Russian long-range aviation and other Russian military components, including air and maritime intelligence collection platforms monitoring NORAD responses. On March 25, 2015, Marine Corps Deputy Commandant for Aviation Jon M. Davis told a Senate Armed Services Committee Subcommittee that the F-35B would achieve Initial Operating Capability in summer 2015. Director Bogdan told a House Armed Services Committee Subcommittee on March 5, 2015, that the JSF program was executing well across the entire acquisition spectrum. He also mentioned he expected various JSF software blocks to be delivered to the Marine Corps later that year and that the Air Force should receive Block 3i software capabilities between August and December 2016. Bogdan also mentioned that Block 3F software capability is planned for delivery in Fall 2017, though this could still be delayed, and announced that 36 production aircraft were delivered in 2014 and an overall total of 124 JSF had been delivered to operational, test, and training sites with the production line running two months behind schedule.[85]

An October 21, 2015, House Armed Services Committee hearing saw Bogdan contending the F-35 was "executing well across the entire spectrum of acquisition to include development and design, flight test, production, fielding and base standup, sustainment of fielded aircraft, and building a global sustainment enterprise." He also asserted that Block 3F, the final version of the software, had been implemented in a flight test, and that aircraft had been delivered to British, Dutch, Italian, and Norwegian customers. He then contended that prices for all three variants would continue dropping into the 2020s.[86]

This same hearing saw Rep. Marc Veasey (D—TX) question Bogdan about problems with the Helmet Mounted Display System (HMDS) used by JSF pilots whose funding Veasey contended had been damaged by sequestration. Bogdan replied that HMDS funding was part of a system development and demonstration program which had not been adversely impacted by sequestration. He also responded to Veasey's question about the helmet's weight stressing that no helmet sensors are being charged and that lighter and stronger material is being used for strapping and cushioning the HMDS.[87]

On April 25, 2016, Senator Orrin Hatch (R—UT) spoke in support of the JSF on the Senate floor. Noting the emergence of geopolitical threats such as Russia's conquest of Crimea, Iranian ballistic missile tests, Chinese assertiveness in the South Chinese Sea, and North Korea's constant war threats with South Korea, Hatch stressed that the JSF could penetrate advanced enemy air defenses and neutralize ground targets. Acknowledging the frustrations of so many with JSF's protracted acquisition process, Hatch noted that JSF's cost had dropped to under $100 million per unit in the past five years and was expected to achieve an $85 million per aircraft fly away cost by 2019. He also noted JSF's positive performance against legacy aircraft such as the F-16 and F/A-18 in aircraft combat scenarios and stressed allied support for JSF, noting Israel's Defense Minister recently said, "I'm very happy that we'll know how to preserve the qualitative military edge of the Israeli Defense Forces and Israeli Air Force through acquisition of this important plane."[88]

In the Senate version of the FY 2017 defense appropriations bill, funding was provided for 63 JSF which was six fewer than provided for in the FY 2016 defense appropriations legislation with provisions for 45 fewer JSF's for the Air Force between 2017 and 2021. The Appropriations Committee expressed concern that current programmed quantities would not support initially planned fielding of JSF squadrons and recommended an additional $100 million in advanced procurement while encouraging the Air Force to revisit JSF procurement quantity in its FY 2018 budget request. The Committee also expressed concern about Navy delays in previously planned production increases for the JSF carrier variant and that the Undersecretary of Defense for Acquisition, Technology, and Logistics should review block buy strategy before requesting such authority from congressional defense committees.[89]

A February 16, 2017, House Armed Services Committee hearing saw Bogdan announce that JSF's fleet exceeded 210 aircraft and surpassed 73,000 flight hours. He also noted overseas deployment to the Netherlands and JSF's participation in the United Kingdom's Farnborough International Air Show and Royal International Air Tattoo. Specific program accomplishments, he noted, included successful 2016 testing of the F-35A internally mounted GAU-22 25-millimeter cannon and ground testing of the F-35B and F-35C centerline cannon pod. He also noted successful Automatic Logistics Information System (ALIS) performance during ashore and afloat test and deployment events and enhancements in cyber protection.[90]

Bogdan also maintained steady progress was being made in SDD with this flight testing projected to end in February 2018; that DOD had directed the program to main resources to deliver Block 3F capability by May 2018; and that remaining SDD costs are estimated to be $3.2 billion. He also told committee members that the ability to fix missions systems software had increased from three to four months to 30–45 days; that ALIS 2.0.2 is approximately four months late with its first fielding to occur in March 2017 at Nevada's Nellis Air Force Base; and that there are 100 Category 1 (Must Fix) deficiencies with 25 of these being corrected and verified as fixed, 33 have been corrected but await testing to verify they are fixed, 39 are in the process of being fixed, and 2 are being fixed. Additionally, he noted the JSF program is solving excessive naval variant vertical oscillations during carrier launch which stem from a nose landing gear strut being compressed as the catapult initial pre-tension load pulls on the nose landing gear, with the hold back bar restraining the aircraft from additional forward movement resulting from engine thrust.[91]

During 2016 JSF delivered 46 aircraft out of a planned 53 including 40 from the Fort Worth Final Assembly and Checkout Facility and 6 from a satellite facility in Cameri, Italy. The 2017 delivery goal was 66 aircraft with 61 coming from Fort Worth, 3 from Cameri, and 2 from a Nagoya, Japan, facility. September 2016 saw a Marine JSF participate in a Live Fire Test at New Mexico's White Sands Missile Range, where it detected, tracked, and targeted a low-flying MQ-170E drone aircraft and passed this information using the JSF's Multifunction Advanced Data Link (MADL) to the Aegis combat system aboard the *USS Desert Ship* (LLS-1) which fired a Standard Missile-7 from "over-the-horizon" shooting down the drone. Bogdan concluded his remarks stressing the JSF's upcoming focus areas are:

- Completing development within existing time and resources;
- Delivering full Block 3F capabilities;
- Smoothly transitioning from development to Follow-On-Modernization;

- Completing production ramp-up while continuing to improve quality and delivery schedule;
- Continuing global sustainment enterprise growth; and
- Improving the fielded fleet's performance.[92]

Testifying at this hearing, Air Force Lt. General Jerry D. Harris, Jr., the Deputy Chief of Staff for Strategic Plans and Requirements, noted the Block 4 upgrade is currently in early planning stages but is expected to bring increased capability beginning in FY 2021 and every two years with the goal of meeting estimated threats in 2025 and beyond. These capability improvements include integrating additional weapons and upgrades to electronic warfare systems, datalink systems, and radar. He asserted the Air Force is placing acute importance on a hardware upgrade designated Technical Refresh 3 which will provide an improved integrated core processor, improved panoramic cockpit display (PCD), a more capable aircraft memory system, and other classified hardware changes.[93]

JSF Program Milestones 2013–2016

In August 2013 the second round of F-35B trials were completed on the *USS Wasp*; the first F-35C was delivered to Eglin AFB, FL, on June 22, 2013; and Lockheed Martin delivered the 100th JSF to Luke AFB, AZ, on December 13, 2013.[94] On May 9, 2016, the Air Force announced the development of Block 3i software for Initial Operating Capability while also providing initial warfighting capability on upgraded computer hardware software; and on August 2, 2016, Air Combat Commander General Hawk Carlisle declared the Air Force's JSF combat ready with it being capable of conducting basic close air support, interdiction, and limited suppression/destruction of enemy air defenses in a contested operational environment with an operational squadron of 12–24 aircraft; the ability to conduct and deploy operational missions using a program of record missions and mission systems, and possessing all necessary logistics and operational elements.[95]

Other recent JSF program developments include the JSF's carrier version conducting tests in the Atlantic Ocean from the *USS George Washington* in August 2016, a November 19, 2016, announcement of progress made in JSF pilots helmet including the ability for pilots to display various imagery modes including thermal, night vision, and actual vision along with the ability to achieve look-through-the-aircraft capability while giving pilots a clear 360-degree picture through daylight and low-light settings; and a

February 3, 2017, agreement between Lockheed Martin and DOD enabling the JSF to achieve a $728 million price reduction with the Air Force per unit cost dropping to $94.6 million (7.3%), the Marine Corps version to $122.8 million (6.8%), and the Air Force version to $121.8 million (7.9%). It is possible these cost reductions were achieved in response to President Donald Trump's pre-presidential tweet that the program cost was too expensive.[96]

Department of Defense Inspector General Reports

JSF performance has also received often critical scrutiny from the DOD Office of Inspector General (DODIG). A significantly redacted January 2006 DODIG report noted that the JSF program office needed to improve its controls over accelerated export of unclassified technology to foreign companies. It also mentioned that the JSF program office needed to decrease inadvertent or unauthorized access to controlled technologies by continuously monitoring risks to the JSF program, revising the protection plan as new risks occur, and ensuring contractors apply countermeasures to protect technology.[97]

A September 2013 DODIG report stressed numerous concerns about the JSF program office including:

- Not ensuring Lockheed Martin and its subcontractors applied rigor to design, manufacturing, and quality assurance processes.
- Failing to flow down critical safety item requirements.
- Ensuring Lockheed Martin flowed down quality assurance and technical requirements to contractors.
- Establishing an effective quality assurance organization.
- Ensuring that the Defense Contract Management Agency (DCMA) performed adequate quality assurance oversight.
- DCMA did not sufficiently perform quality assurance oversight of JSF contractors.[98]

A March 11, 2015, DODIG follow-up to this 2013 report found that the JSF program office had achieved generally conformed to quality requirements and had demonstrated quality management system performance improvements in the interim. DODIG remained concerned that the JSF office had not made sufficient progress to achieve full compliance with Section 802 of the 2004 National Defense Authorization Act mandating quality control in procuring critical aviation security items; creating an independent quality assurance organization and ensuring its adequate staffing to perform effective JSF program oversight; ensuring Lockheed Martin was taking requisite steps to reduce the assembly defect rate in order to meet full-rate production goals; ensuring this company's software quality management processes were performing sufficiently to prevent software defects; and ensuring that Lockheed Martin delivered contractual requirements to subcontractors, evaluated deliverables for contractual compliance, and allowed minor nonconformances to only be approved by the proper authority.[99]

2016 DOD Director of Operational Test and Evaluation Report

The FY 2016 report by this office on various DOD operational testing programs noted that JSF's program office acknowledged schedule pressure exists for completing SDD and starting Initial Operational Test and Evaluation by the planned August 2017 date in the program's integrated master schedule. Additional problems documented in this report include delays in Block 3F missions systems development and flight testing probably taking until July 2018 to complete; delays and incomplete Block 3F weapons delivery accuracy and ongoing weapons integration problems; continued ALIS shortfalls and delays including late delivery of ALIS version 3.0 with the full version of this for the F-35B not being released until 2018; insufficient progress in developing, integrating, and testing Air-to-Air Range infrastructure instrumentation into the JSF; and delays in providing training simulators in Block 3F configuration to initial training centers and operational locations. These delays could push initial operational testing and evaluation capability to 2018, 2019, or 2020.[100]

Various GAO JSF Reports

JSF program activities and developments continue providing a target-rich environment for JSF scrutiny. On June 19, 2013, GAO Acquisition Sourcing and Management Director Michael Sullivan told a Senate Appropriations Committee subcommittee that JSF program performance improved in 2012 with most management and development test objectives being met. Enhancements were made in key technical risks such as the HMDS, the ALIS system which predicts and diagnoses aircraft maintenance and supply problems, the arresting hook system for the carrier variant, bulkhead structural durability enhancements, and improved software management and output.[101]

Remaining problems include long-term affordability with development and procurement funding costs from 2013 to 2037 being $316 billion for an annual average of $12.6 billion, estimating annual operating and sustainment costs of $18.2 billion for all JSF variants, only 12% of mission system software capabilities being validated, and design changes and reworking continuing to add to program costs and risks.[102]

A November 7, 2013, GAO letter to House Budget Committee Chair Rep. Paul Ryan (R—WI) and Representatives Turner and Sanchez stated that JSF had to fund a portion of its budget sequestration by delaying software research, development, testing, and evaluation.[103] A March 2014 report from this agency mentioned that JSF acquisition costs now approached $400 billion, making it the most expensive defense acquisition program of the United States. This report also indicated that software testing problems could hinder warfighting capabilities in the areas of mission systems and flight sciences which the armed services expect. The purpose of missions systems testing is verifying software systems and capabilities providing critical warfighting capabilities function properly and flight science systems verify basic aircraft flying capabilities. The report went on to contend that each of the armed services may not receive the JSF warfighting capabilities they expect when these aircraft are delivered and that their delivery dates could be delayed.[104]

Testifying before the House Armed Services Committee on April 14, 2015, GAO's Sullivan noted that technical challenges including on the F-35B durability test aircraft, engine failure, and greater than expected software test growth were likely to produce future JSF cost growth and schedule delays. He also stressed that DOD has a long way to go to reach JSF engine reliability and that planned production increases from 38 aircraft in 2015 to 90 aircraft in 2019 could be challenging due to ongoing late delivery of parts by suppliers.[105]

On March 23, 2016, GAO Acquisition and Sourcing Management Director Michael J. Sullivan testified before a House Armed Services Committee Subcommittee presenting the findings of GAO's annual congressionally mandated report on JSF program progress. He noted that DOD was beginning planning and funding significant new JSF capabilities known as Block 4 which DOD does not plan to include as its own acquisition program but as part of an existing funding baseline which will not make it subject to congressional and regulatory oversight. Projected Block 4 development costs are anticipated to increase near-term funding needs as Table 4.4 demonstrates:

This assessment went on to contend that while JSF program acquisition costs have decreased since 2014, forthcoming operational and sustainment costs are estimated to be around $1 trillion which DOD officials believe to be unaffordable. Peak production rates for US aircraft are expected to be reached in 2022 with the program expected to require an annual average of $12.7 billion to complete aircraft procurement through 2038 with annual numbers of aircraft purchased by each service expected to jump from 63 in 2016, to peak at 120 annually between 2022 and 2029, before dropping to 62 in 2038.[107]

Table 4.5 provides information on the progress of various tests of JSF software blocks as of December 2015:

Table 4.4 Projected Block 4 development costs[106]

2016	$91 million
2017	$264.9 million
2018	$609.4 million
2019	$649.2 million
2020	$655.3 million
2021	$668.2 million

Table 4.5 JSF software block test progress[108]

Block 1 and 2A	Training capability: includes basic navigation, mission planning, flight displays, voice communication, and threat jamming		Percent test points complete 100%
Block 2B	Initial warfighting capability: Includes basic close air support/interdiction, and initial air-to-air and initial air-to-air capability	Required for 2015 Marine Corps Initial Operating Capability (IOC) 100%	100%
Block 3i	Extension of Block 2B capabilities: Includes adding Block 2B capabilities to new technology hardware, export compliance, and new helmet with improved display system	Required for 2016 Air Force IOC	100%
Block 3F	Full warfighting capability: Includes full avionics and weapons envelope.	Required for 2018 Navy IOC	18%

Positive assessments of this 2016 GAO JSF program assessment are airframe and engine contractors reporting improved efficiency and supply chain performance along with improving reliability and maintainability. Engine manufacturing deliveries remain steady, as have labor hours required for engine assembly. Shortcomings stressed in this analysis include the F-35 fleet falling short of reliability and maintainability in 9 of 19 areas though there is time for program improvement. As of August 2015 the fleet had only flown a cumulative total of 35,940 hours out of the 200,000 cumulative flight hours required for system maturity. Problems remain with Pratt & Whitney engine reliability with F-35A and F-35B engines being at 55% and 63% reliability of where they should be. Concern was also expressed over whether the JSF can sustain annual funding exceeding $14 billion per year in 2022 when it will compete for DOD funding with the long-range strike bomber and KC-46A tanker.[109]

A November 2016 GAO report on DOD weapons system requirements stressed that both the JSF and CH-53K Heavy Lift Replacement Helicopter did not conduct sufficient systems engineering prior to beginning product development. Consequently, both of these programs began development with significant risks and limited understanding of the challenges posed by their technical requirements. Neither program established a functional or allocated baseline before beginning development.

GAO also maintained that neither DOD nor JSF contractors conducted detailed systems engineering to satisfactorily retire risk, establish an allocated baseline, truly understand the challenge posed by their requirements, and possess a sound executable business case. Most JSF systems engineering occurred after development began and the program experienced major cost and schedule growth with development costs increasing over 60% above initial estimates with Initial Operating Capability being delayed over five years and restructured three times.[110]

An October 2017 GAO JSF analysis noted that DOD was currently sustaining over 250 JSF with plans to triple the fleet by 2021 but faced lingering sustainment problems impacting warfighter readiness with these, as shown in Table 4.6.

This GAO assessment also noted that the DOD has taken some steps to reduce estimated JSF sustainment costs such as establishing Cost War Room to identify and implement cost-reduction measures intended to reduce JSF program office 2012 operating and cost estimates 30% by 2022. The program office had completed 38 improvement projects expected to result in $1.7 billion in operating and support cost avoidance

Table 4.6 October 2017 JSF sustainment challenges[111]

Key sustainment challenge	*Description*
Limited depot repair capacity	DOD's capabilities to repair F-35 parts at military depots are six years behind schedule, which has resulted in average part repair times of 172 days—twice that of the program's objectives.
Spare parts shortages	Spare parts shortages are degrading readiness. From January through August 7, 2017, F-35 aircraft were unable to fly about 22% of the time due to shortages of parts.
Undefined technical data needs	The DOD has not defined all the technical data it needs from the prime contractor, and at what cost to enable competition of future sustainment contracts. Technical data include the information necessary to ensure weapon system performance and support.
Unfunded intermediate-level maintenance capabilities	The Marine Corps initial F-35 deployments on ships in 2018, and potentially the initial ship deployments for the Navy, will not include required intermediate-level maintenance capabilities. Such capabilities provide a level of support between the squadron and the depots, so that repairs can be done at sea. The DOD has identified initial intermediate capabilities that it plans to implement, but funding to do so is not yet in place.
Delays in ALIS development and uncertain funding	The ALIS is a complex system supporting operations and maintenance that is central to F-35 sustainment, but planned updates will likely be delayed, and requirements for ALIS development are not fully funded.

by May 2017. However, this was offset by an increase in projected flying hours, extension of the JSF life cycle from 56 to 60 years, and refinements to cost models increasing program life cycle operating and support costs from approximately $850 billion in FY 2012 to $1.1 trillion in FY 2016.[112]

GAO recommendations to the Undersecretary of Defense for Acquisition, Technology, and Logistics, and the JSF Program Executive officer for rectifying these deficiencies include:

- These two officials revising sustainment plans to ensure they include key requirements and decision points to fully implement F-35 sustainment strategy and aligned funding plans.
- These officials reexamining metrics used to hold the contractor accountable under fixed-price, performance-based contracts to ensure such metrics are objectively measurable, fully reflect processes the contractor has control over, and drive desired behaviors by all stakeholders.

- These officials, prior to entering multi-year fixed-price, performance-based contracts, ensure that the DOD has sufficient knowledge of actual sustainment costs and technical characteristics after baseline development is complete and the system reaches maturity.
- These officials take steps to improve communication with the military services and provide more information about how the F-35 sustainment costs they are charged relate to the capabilities received[113]

Rand Cooperative Acquisitions Report

The promise of resource sharing, enhancing military interoperability, and cost savings through the participation of multiple US armed services, multiple foreign militaries, and multiple domestic and foreign contractors has long been heralded by JSF advocates as a key justification for this program. This rationale received serious criticism in a December 2013 Rand Corporation report. This report stemmed from a request from the Commander of the Air Force's Material Commander General Janet C. Wolfenbarger to analyze benefits and costs of historical joint aircraft programs from the early 1960s though the JSF. This report addressed the following five questions:

- Have historical joint aircraft programs saved Life Cycle Cost (LCC) compared with comparable single-service aircraft programs?
- Is JSF on track to save LCC compared with notional single-service fighter programs?
- What factors contributed to cost outcomes in historical joint aircraft programs and JSF?
- What implications does a joint aircraft approach have for the industrial base?
- What are joint aircraft approach implications for operational and strategic risk?[114]

Rand's research and data analysis covered up until November 2011 and their conclusions found *historical joint aircraft programs have experienced higher rates of acquisition cost growth than single-service aircraft programs and have not saved overall LCC.* The report compared research, development, test, and evaluation (RDT&E) and procurement cost growth estimates for historical single-service and joint aircraft programs at comparable points in their program history measuring cost growth in constant purchasing power dollars to properly account for inflation. Rand found joint service programs experience significantly higher acquisition cost growth than single-service programs.[115]

JSF is not on the path to deliver promised LCC savings. Rand noted that while JSF was structured to overcome some problems experienced by historic joint fighter programs, it faced the challenge of meeting three significantly different service requirements (along with international partner requirements) and ambitious technical and performance objectives (including supersonic low-observable STOVL) into a single core aircraft design with an 80% service variant commonality goal. Rand maintained its analysis of DOD SAR data showed JSF LCC were higher than if the services pursued three separate fighter programs.[116]

Difficulty of reconciling diverse service requirements in a common design is a major factor in joint cost outcomes. Rand noted that from the Tactical Fighter Experimental (TFX) F-111 program in the 1960s through the JSF, attempting to accommodate multiple operating environment, service-specific missions, and divergent performance and technical requirements in common joint fighter designs increases program and technical complexity and risks prolonging RDT&E and increasing joint acquisition costs. Conversely, service-specific requirements and demands tend to produce less commonality and lead to more variants reducing the main course of joint cost savings anticipated in procurement and operations and support.[117]

Joint aircraft programs are associated with a shrinking combat industrial base. Pursuing joint aircraft programs in recent decades has occurred in the context of the number of major fighter plane contractors falling from eight in 1985 to three in 2013. Lockheed Martin is the only prime contractor actively leading the JSF fifth generation program for the foreseeable future. This reduces the potential for future competition, discourages innovation, and makes cost control more difficult. Acquisition decision makers and governmental and military policymakers must understand this in determining the next fighter development program and how a smaller industrial base will affect this plane's development regardless of whether it is for a single service or a joint program.[118]

Joint aircraft programs could potentially increase operational and strategic risk to warfighters. Rand contends having various fighter platform types across service inventories hedges against design flaws and maintenance and safety problems which could produce fleet-wide stand-downs. Multiple fighter platforms increase options available to meet unexpected enemy capabilities. During the Korean War, the Air Force was rapidly able to upgrade its F-86 Sabre to meet the unexpected introduction of the Soviet Mikoyan-Gurevich (MiG-15) which was more capable than existing Air Force or Navy fighters. If the Air Force or Navy placed exclusive reliance on a single joint fighter other than the F-86, it might have been unable to respond quickly to the new threat posed by the MiG-15. Greater US military reliance on joint fighters produces fewer options to meet unanticipated future threats and cries and unexpected safety and reliability problems capable of grounding entire fleets of specific aircraft types. Rand concluded its assessment maintaining that the DOD avoid future joint fighter and other complex joint aircraft programs unless participating services have identical and stable requirements.[119]

2014 DOD Selected Acquisition Report

A December 31, 2014, report from DOD's Undersecretary of Defense for Acquisition, Technology, and Logistics noted significant financial efficiencies in JSF costs. This SAR mentioned that overall JSF costs had decreased from $398.6 billion to $391.1 billion. It also documented that aircraft costs had fallen from $329.9 billion to $324.1 billion (−1.8%) due to incorporating prime contractor and subcontractor labor rates for all JSF variants saving $4.4 billion and revised escalation indices saving $3.4 billion. Additional savings of $1.1 billion came from reductions in initial spares requirements due to technical baseline maturation and other factors. However, these decreases were partially offset by a $4.4 billion increase for revised airframe estimates.[120]

JSF engine subprogram costs decreased from $68.6 billion to $67.0 billion (1.6%) due to revised escalation indices of $700 million, reductions in initial spares requirements of $600 million due to technical baseline maturation, and revised downward estimates of $500 million based on actual costs from early low-rate initial production lots. Such decreases were partially offset by increases of $200 million resulting from procurement profile changes.[121]

US JSF Industrial Participation

A significant number of companies in the United States are involved in manufacturing various JSF components. These companies and their workforce are spread across the United States and have likely influenced the willingness of Congress to continue supporting this program despite its cost increases and repeated delays. The data below in Table 4.7 indicates that JSF

Table 4.7 JSF supplier locations/economic impact[122]

	Supplier locations	*Direct/indirect jobs*	*Estimated economic impact*
Alabama	10	178	$12.2 million
Arizona	20	1877	$227.9 million
Alaska	5	81	$5.5 million
California	277	27,965	$5.079 billion
Colorado	11	354	$25.7 million
Connecticut	80	8519	$645.8 million
Delaware	1	4	<1 million
Florida	94	10,208	$1.401 billion
Georgia	17	2000	$234.7 million
Idaho	2	55	$3.7 million
Illinois	35	3555	$422.9 million
Indiana	11	2041	$166.6 million
Iowa	4	1989	$163.5 million
Kansas	20	467	$33.1 million
Kentucky	3	58	$4.2 million
Maine	2	825	$68.2 million
Maryland	36	3296	$830.4 million
Massachusetts	76	1035	$59.9 million
Michigan	17	2300	$185.7 million
Minnesota	25	480	$31.8 million
Mississippi	1	225	$18.6 million
Missouri	22	545	$38.6 million
Montana	2	8	< $1 million
Nevada	4	135	$25.7 million
New Hampshire	47	2218	$979.1 million
New Mexico	1	4	< $1 million
New Jersey	39	1376	$101 million
New York	72	6375	$733.1 million
North Carolina	10	735	$63.4 million
North Dakota	1	4	< $1 million
Ohio	11	2041	$166.6 million
Oklahoma	7	387	$30 million
Oregon	18	754	$57.6 million
Pennsylvania	42	477	$27.2 million
Puerto Rico	1	76	$2.5 million
Rhode Island	5	51	$2.9 million
South Carolina	6	135	$48.1 million
South Dakota	1	4	< $1 million
Tennessee	5	149	$17 million
Texas	79	39,439	$ 5.179 billion
Vermont	3	163	$128.8 million

(*continued*)

Table 4.7 (continued)

	Supplier locations	*Direct/indirect jobs*	*Estimated economic impact*
Virginia	18	682	$51.7 million
Utah	10	1889	$161.5 million
Washington	13	2133	$173.8 million
West Virginia	1	8	<$1 million
Wisconsin	5	70	$4.3 million
Total	1174	127,170	$17,692,127,170 billion

facilities and workforce are in geographic locations potentially represented by 90 US senators and 424 US representatives. The following chart lists the states having JSF contractors or subcontractors, the number of supplier locations in each state and territory, their workforce, and estimated annual economic impact. Only Alaska, Hawaii, Louisiana, Washington, DC, and Wyoming do not have JSF suppliers.

Examples of some US companies and US subsidiaries of foreign companies involved or potentially involved in aspects of JSF production are shown in Table 4.8.

Another way of understanding the widespread political support JSF receives in Congress is looking at the campaign contributions made to a bipartisan group of legislators by aerospace industry companies and labor unions to members in states or districts with significant JSF contracting facilities. Table 4.9 lists a representative sampling of 2013/2014 campaign cycle contributions, arranged alphabetically by state, made to these representatives and senators campaign committees by Lockheed Martin, other major aerospace companies, and specialized labor unions. Those serving on relevant congressional armed services and appropriations committees during the 114th Congress (2015–2016) or earlier are also noted.

Examples of 2015–2016 campaign cycle aerospace industry and union contributions to Senate races are shown in Table 4.10.

A congressional JSF caucus consisting of 48 representatives from both parties was formed on November 9, 2011. Chaired by Rep. Kay Granger (R—TX) and Norm Dicks (D—WA,) it seeks to promote the JSF to members of Congress and educate Congress about what they see as its benefits. Most of these members represent districts with JSF contractors.[126]

Table 4.8 Selected JSF US contractors[123]

Accurus Aerospace—Athens, GA	Machining
Adacel—Orlando, FL	Embedded speech recognition system
Alcoa—Cleveland, OH	Aluminum structural die forgings
Possible alternative location—Lafayette, IN	Aluminum lithium
Ametek Aerospace—Wilmington, MA	Sensor suites, data management systems, cooling and ventilating systems, environmental control systems, various subassemblies
Avionics Specialties (Partnered with Honeywell—Earlysville, VA)	Low-observable air data system, low-observable multifunction probes
Circor Aerospace/Aerodyne Controls—Hauppauge, NY	Pneumatic power module for International Telephone and Telegraph (ITT) weapons ejection rack
Click Bond—Watertown, CT Carson City, NV	High-strength structural nutplates, structural adhesives, composite fasteners
Curtiss-Wright Flight Systems—Shelby, NC	Ordnance hoist system, quick latch system
Gastonia, NC	Ordnance hoist system, quick latch system
Cytec Engineered Materials—Woodland Park, NJ	Composite materials/structural composites
Greenville, TX	Epoxy and Bismaleimide Prepreg product forms in F-35B
Anaheim, CA	Epoxy and Bismaleimide Prepreg product forms in F-35B
Dassault—Auburn Hills, MI	Robotic painting and coating
Ducommun Aerostructures—Gardena, CA	Inlet lipskins surrounding jet engines
El Mirage, CA	Inlet lipskins surrounding jet engines
EDO Corporation—Long Island, NY	Landing aid antennas
General Dynamics—Saco, ME	GAU-22/A Gun Systems
Williston, VT	GAU-22/A Gun Systems
Marion, VA	Advanced lightweight composite radomes housing radar antenna
Goodrich—Cleveland, OH Oldsmar, FL	Landing gear system, advanced friction materials for the LiftFan™ clutch
Vergennes, VT	Wiring harness Actuators for landing gear, bay doors, utility access
Hamilton Sundstrand (United Technologies)—Rockford, IL	Electric power generation and conversion systems, engine controls, gearbox and externals for Pratt & Whitney F135 engine, flight controls for actuation systems
Harris—Palm Bay, FL	Avionics

(*continued*)

Table 4.8 (continued)

Hexcel—Stamford, CT	Carbon fiber
Kaiser Aluminum—Carlsbad, CA	Fabricated aluminum plate
Kidde Aerospace—Wilson, NC	Engine fire detection system, overheat detection system, dry bay suppression system
Kulite Semiconductor Products—Leonia, NJ	Pressure sensors
L-3 Communications—Rolling Meadows, IL	Crash recorder/crash survivable memory unit, panoramic compact display
LAI International—Tempe, AZ	Aluminum and titanium panels
Westminster, MD	Titanium vertical tail fin components
Minneapolis, MN	Air frame panels and subassemblies
Lockheed Martin—Fort Worth,	Final assembly site
TX	Center wings, stealth coating
Marietta, GA	Canopy components
Pinellas Park, FL	Electro-optical targeting system
Ocala, FL	
Northrop Grumman—Palmdale, CA	Center fuselage, electro-optical distributed aperture system
Parker Aerospace—Irvine, CA	Control systems, air and fuel division
Elyria, OH	Nichols Airborne Division
Smithtown, NY	Electronics Systems Division
Pratt & Whitney—Dayton, OH	Compressor research facility
(Air Force Research Laboratory)	F135 Engine
Hartford, CT	
Raytheon—El Segundo, CA	Space and airborne systems headquarters, integrated core processor, digital anti-jam receiver
Rolls-Royce—Indianapolis, IN	LiftFan gearbox, clutch, driveshaft, and nozzle
Smith Aerospace/GE Aviation Systems—Grand Rapids, MI	Advanced memory unit, fuselage remote interface
W.L. Gore—Landenberg, PA	Interconnect devices and cables

Table 4.9 Selected aerospace industry and labor union congressional campaign contributions[124]

Rep. Trent Franks (R—AZ)	Honeywell $10,000
Armed Services	Lockheed Martin $10,000
	Northrop Grumman $10,000
Rep. Paul Gosar (R—AZ)	General Dynamics $2000
Rep. Duncan Hunter (R—CA)	BAE Systems $10,000
Armed Services	Honeywell International $10,000
	Northrop Grumman $10,000
	Raytheon $10,000
	Lockheed Martin $8000

(continued)

Table 4.9 (continued)

Rep. Darrell Issa (R—CA)	Lockheed Martin $10,000 Honeywell International $7554 Northrop Grumman $7500
Rep. Loretta Sanchez (D—CA) Armed Services	Lockheed Martin $10,000 Machinists/Aerospace Workers Union $10,000 Northrop Grumman $10,000 Raytheon $10,000 Honeywell International $8500
Rep. Joe Courtney (D—CT) Armed Services	Honeywell International $10,000 Lockheed Martin $10,000 United Technologies $10,000 Machinist/Aerospace Workers Union $10,000 Northrop Grumman $10,000 Raytheon $10,000
Rep. John Larson (D—CT)	Honeywell International $10,000 Lockheed Martin $10,000 United Technologies $10,000 Machinist/Aerospace Workers Union $10,000 Raytheon $8500
Rep. Mario Diaz-Balart (R—FL) Appropriations-Defense Subcommittee	Boeing $10,000 Honeywell International $10,000 Northrop Grumman $10,000 United Technologies $7500
Rep. Jeff Miller (R—FL) Armed Services	BAE Systems $10,000 General Dynamics $7500 Honeywell International $7,5000 Lockheed Martin $10,000 Northrop Grumman $10,000 United Technologies $10,000
Rep. Tom Rooney (R—FL) Appropriations	Boeing $6000 General Dynamics $5000 Honeywell International $10,000 Lockheed Martin $10,000 Northrop Grumman $10,000 United Technologies $10,000
Rep. Doug Collins (R—GA)	Lockheed Martin $4000
Rep. Tom Price (R—GA)	Boeing $10,000 Honeywell International $10,000 Lockheed Martin $10,000 Raytheon $10,000
Rep. Lynn Westmoreland (R—GA)	General Dynamics $8500 Lockheed Martin $10,000 United Technologies $10,000

(*continued*)

Table 4.9 (continued)

Rep. Larry Bucshon (R—IN)	Lockheed Martin $4000
Rep. Andre Carson (D—IN) Served on Armed Services during 113th Congress	BAE Systems $7000 Boeing $8500 General Dynamics $3500 Lockheed Martin $3000 Machinists/Aerospace Workers Union $10,000 Northrop Grumman $10,000 Raytheon $10,000 Rolls-Royce $10,000
Rep. G.K. Butterfield (D—NC)	Machinists/Aerospace Workers Union $10,000 Lockheed Martin $8000 United Technologies $5500
Rep. Walter Jones (R—NC) Armed Services	Lockheed Martin $8000 Northrop Grumman $10,000
Rep. Bill Johnson (R—OH)	Honeywell International $10,000 Lockheed Martin $6000 Northrop Grumman $10,000
Rep. Michael Turner (R—OH) Armed Services	BAE Systems $10,000 Boeing $ 10,000 General Dynamics $10,000 Honeywell International $10,000 Lockheed Martin $10,000 Northrop Grumman $10,000
Rep. Robert Brady (D—PA) Armed Services	Lockheed Martin $2000 Machinists/Aerospace Workers Union $5000 Northrop Grumman $7500
Rep. Chaka Fattah (D—PA) Appropriations	Boeing $8000 Lockheed Martin $10,000 Machinists/Aerospace Workers Union $10,000 Northrop Grumman $7500 Raytheon $10,000 United Technologies $7500
Rep. Kay Granger (R—TX) Appropriations-Defense Subcommittee Vice-Chair (Lockheed Martin JSF assembly facility is in her district)	General Dynamics $10,000 Honeywell International $10,000 Lockheed Martin $10,000 Northrop Grumman $10,000 Raytheon $10,000 United Technologies $10,000
Rep. Michael McCaul (R—TX)	Boeing $10,000 Honeywell International $9000 Lockheed Martin $10,000 Northrop Grumman $10,000 Raytheon $10,000 United Technologies $10,000

(*continued*)

Table 4.9 (continued)

Rep. Randy Neugebauer (R—TX)	Lockheed Martin $10,000
Rep. Jaime Herrera Beutler (R—WA)	Boeing $10,000
Appropriations	Honeywell International $7000
	Lockheed Martin $6000
	Northrop Grumman $10,000
Rep. Derek Kilmer (D—WA)	Boeing $10,000
Appropriations	Honeywell International $10,000
	Lockheed Martin $7000
	Machinists/Aerospace Workers $10,000
	Northrop Grumman $10,000
	Raytheon $10,000
	United Technologies $7000
Rep. Rick Larson (D—WA)	Boeing $10,000
Armed Services	Honeywell $10,000
	Lockheed Martin $8000
	Machinists/Aerospace Workers Union $5000
	Northrop Grumman $10,000

Table 4.10 Selected aerospace industry US Senate campaign contributions[125]

Sen. John McCain (R—AZ)	BAE Systems $46,400
Armed Services Committee Chair	General Atomics $38,850
	Raytheon $45,425
Sen. Richard Blumenthal (D—CT)	United Technologies $35,225
Armed Services	
Sen. Johnny Isakson (R—GA)	General Dynamics $24,300
Foreign Relations	
Sen. Mark Kirk (R—IL)	Boeing $26,755
Appropriations (Lost to Tammy Duckworth)	
Sen. Roy Blunt (R—MO)	Boeing $55,291
Appropriations (Defense Subcommittee)	
Sen. Kelly Ayotte (R—NH)	BAE Systems $32,250
Armed Services (Lost to Maggie Hassan)	Boeing $31,950
	Raytheon $45,410
Sen. Charles Schumer (D—NY)	Lockheed Martin $93,950
Minority Leader	
Sen. Richard Burr (R—NC)	Northrop Grumman $40,300
Intelligence Committee Chair	
Sen. John Hoeven (R—ND)	United Technologies $13,000
Appropriations	
Sen. James Lankford (R—OK)	Honeywell International $35,000
Sen. Tim Scott (R—SC)	Boeing $62,999
Sen. Patrick Leahy (D—VTO)	Boeing $23,750
Appropriations (Defense Subcommittee)	Lockheed Martin $34,100
	United Technologies $22,750

Analysis

JSF has achieved success during its development and evolution but has also experienced significant management and performance problems which have made it DOD's most expensive weapons system ever involving nearly $400 billion to purchase 2400 aircraft. This expense is more than twice as high as the manned lunar program and JSF is seven years behind schedule and $163 billion over budget. These exacerbating factors occur when the Obama and Trump Administrations and Congress are grappling over how to reduce the federal budget deficit and shrinking the US military's size is recommended as one method to achieve this result.

JSF is making some progress in resolving its problems under Bogdan's leadership and WSARA but the price per unit cost of planes produced at Lockheed Martin's Fort Worth assembly line is $115 million per aircraft. Pilots are conducting test flights and training missions at bases in Arizona, California, Florida, Maryland, and Nevada. JSF is a stealth aircraft designed to evade enemy radars with over 24 million lines of software code. JSF pilot Lt. Col. David Berke stresses the voluminous amount of information the JSF gathers and processes for him as a pilot which he contends is a significant advantage over current aircraft. Air Force Chief General Mark Welsh says the F-35 is needed to give the United States and its allies the ability to control the air in future conflicts and that air superiority is not guaranteed.[127]

For the JSF 2015–2016 was the originally scheduled initial operating debut. During a 2014 interview for *60 Minutes*, Marine Lt. General Robert Schmidle described what he saw as JSF's advantage in combat:

> I shouldn't get into the exact ranges because those ranges are classified, but what I can tell you is that the range at which you can detect the enemy as opposed to when he can detect you can be as much as ten times further when you'll see him before he'll ever see you, and down to five times … the range.
>
> The F-35's radars, cameras, and antennas would scan for 360 degrees around the plane searching for threats and projecting, … the altitude and speed of an enemy aircraft, onto the visor of a helmet custom-fitted to each pilot's head.[128]

Existing US enemies such as transnational terrorist groups like ISIS are not a significant threat to US jets. US policymakers are more concerned about emerging military aircraft threats such as Russian T-50 and Chinese J-20 stealth fighters and the threats they could pose to the JSF. These policymakers are also concerned with the air defense systems of these countries and countries allied with them including Syria where conventional airpower operations may be conducted. For all of the JSF's high-tech arsenal and capabilities it still faces problems. The pilot's helmet and the computer system it works with cost over $500,000. In February 2014 *60 Minutes* reported that when it visited the Marine Corps station in Yuma, AZ, a helmet malfunction caused a scheduled test flight to be canceled. JSF planes are tested at Edwards Air Force Base and the JSF has to go through 56,000 separate tests involving from making sure a bomb will fall when released from the bomb bay to what happens when the bomb is dropped at supersonic speeds. The F-35 had also been restricted from flying at night because its wingtip lights, shaped to enhance the JSF's stealth contours, failed to meet Federal Aviation Administration standards. JSF also experienced tire stress problems with tires wearing out two to four times faster than expected even though the tires had to be strong enough to withstand a conventional landing and sufficiently bouncy to withstand a vertical landing. There were also problems with stealth coating having gaps due to early work in the JSF program using computer modeling and simulators to replace fight testing to evaluate aircraft performance. Despite these problems, Bogdan told *60 Minutes* that the military was going to buy the JSF.[129]

There is also debate on whether JSF technology has been harvested through espionage by China and Russia. Testifying before the House Homeland Security Committee on April 24, 2012, James Lewis of the Center for Strategic and International Studies contended that JSF cost overruns and delays could stem from cyberespionage and development of China's J-20 fighter. On July 9, 2013, Commissioner Larry Wortzel of the US-China Economic and Security Review Commission told another congressional committee that as early as 2007 Chinese cyberespionage frequently infiltrated JSF contractors BAE Systems, Lockheed Martin, and Northrop Grumman stealing some design plans which have been incorporated into China's new J-31 stealth fighter.[130]

Trump Administration Developments

Additional developments in the Trump Administration saw JSF Program Office leadership transfer from Bogdan to Vice-Admiral Mathias Winter, the F-35C being integrated into the Navy on August 3, 2017, in anticipation of a 2021 operational deployment of a Navy F-35C squadron; a September 3, 2017, test of the F-35C from the aircraft carrier *USS Abraham Lincoln*, and a December 18, 2017, announcement that the JSF's 17-year development phase was complete and that it was being handed over for operational testing.[131]

Despite these successes congressional appropriators remained concerned over various JSF aspects including sustainment, affordability, and transparency. The Senate Armed Services Committee report on the FY 2018 Defense Authorization Act, while acknowledging some DOD progress in cost savings and sustainment affordability, expressed concern that the DOD did not use military service budgets to set these targets. The committee went on to stress that current DOD sustainment strategy did not have the transparency necessary for efficient and effective use of taxpayer dollars since it failed to incorporate service budget input to guide sustainment decisions, prioritize requirements, and identify potential savings.

Consequently, this report directed DOD to report to congressional armed services committees on DOD's plan to improve JSF transparency and affordability by March 1, 2018. The report was to contain.

1. A description of affordability constraints linked to, and informed by, military service budgets to guide sustainment decisions, prioritize requirements, and identify additional areas of savings;
2. Explain existing processes in place and steps taken by the Air Force and Navy to ensure full transparency of JSF sustainment costs they are funding and the corresponding capabilities provided to support their own affordability initiatives; and
3. Any other matter the Secretary of Defense considers relevant.[132]

During a November 9, 2017, testimony before the House Armed Services Committee Marine Corps Deputy Commandant for Aviation Lt. General Steven Rudder expressed concern that the Corps had insufficient pilots for the F-35 while Air Force Deputy Chief of Staff for Operations Lt. General Chris Nowland noted that a Weapons System Sustainment program enabled the Air Force to purchase $95 million in spare parts to support 5 JSF's.[133]

Conclusion

Despite its repeated delays, technical problems, and cost overruns, the JSF is likely to eventually be deployed by the United States even if its numbers are lower than originally planned. On May 24, 2018, the Senate Armed Services Committee passed the FY 2019 National Defense Authorization Act by a 25–2 margin. This legislation authorized $7.6 billion to procure 75 JSF aircraft including $4.2 billion for 47 F-35As, $2.4 billion for 20 F-35Bs; $1 billion for 8 F-35Cs, increasing funding for spare parts, modifications, and depot repair capabilities to establish a solid sustainment base before increasing production overwhelms enterprise aircraft sustainability, fully funds Block 4 Continuous Capability Development and Delivery, and mandates quarterly updates to Congress on JSF status and direction.[134]

The reasons for this recurring commitment to the JSF include so much economic investment, research and development expenditures, and widespread political capital in this project due to bipartisan support and the involvement of a contractor base encompassing large geographic areas of the United States. Concern over potentially emerging airpower threats from China and Russia will also sustain the JSF even with doubts over its technical capabilities, whether its operational range is sufficient for combat missions, mechanical problems, and cost. The United States will ultimately be more concerned with the geopolitical consequences of potentially losing air superiority to probable enemies than with the protracted problems JSF has experienced over the past two decades.

This concern with geopolitical factors affecting US national security, such as those posed by China and Russia, are key emphases in the Trump Administration's December 18, 2017, *National Security Strategy of the United States*; that year's DOD *Annual Industrial Capabilities Report* stressing the imperative for increasing US aerospace workforce quality, restoring military readiness, and building a more lethal military force; the unclassified summary of the January 2018 *National Defense Strategy*, and the February 2018 *Nuclear Posture Review* which all reiterate the return of great power competition in the international security environment and the need for the United States to have conventional and nuclear force capabilities to deal with these continually evolving threats. A Marine Corps F-35B conducted the first U.S. combat strikes against Taliban targets in Afghanistan on September 27, 2018. These factors will result in the JSF's operational deployment although the Trump Administration and Congress will remain acutely interested in restraining program costs and ensuring deployment timetables are met.[135]

Several other countries have also experienced controversy, failure, and success with the JSF and their interactions with this program will be explored and analyzed in subsequent chapters.

Notes

1. Examples of the Brobdingnagian literature on US military acquisition includes Shannon A. Brown, *Providing the Means of War: Historical Perspectives on Defense Acquisition, 1945–2000,* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2005); http://history.defense.gov/Portals/70/Documents/acquisition_pub/

CMHPub70-87-1ProvidingtheMeans.pdf; Accessed April 27, 2017; Thomas C. Lassman, *Sources of Weapons System Innovation in the Department of Defense: The Role of In-House Research and Development, 1945–2000*, (Washington, DC: United States Army Center of Military History, 2008); http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_51-2-1.pdf; Accessed April 27, 2017; J. Ronald Fox, *Defense Acquisition Reform, 1960–2009: An Elusive Goal*, (Washington, DC: United States Army Center of Military History, 2011); http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_Pub_51-3-1.pdf; Accessed April 27, 2017; Elliott V. Converse III, *Acquisition History Volume I: Rearming for the Cold War, 1945–1960*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2012); http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol1.pdf; Accessed April 27, 2017; Paul A.C. Koistinen, *State of War: The Political Economy of American Warfare, 1945–2011*, (Lawrence: University Press of Kansas, 2012) concludes an exhaustively researched multivolume compendium on this topic that is flawed by ideological antimilitary grandstanding; Willam F. Hartung, *Prophets of War: Lockheed Martin and the Military Industrial Complex*, (New York: Nation Books, 2010) is a rhetorical broadside against the JSF's primary contractor, and Walter S. Poole, *Acquisition History Volume II: Adapting to Flexible Response, 1960–1968*, (Washington, DC: Historical Office, Office of the Secretary of Defense, 2014); http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol2.pdf; Accessed April 27, 2017.

2. Jeremiah Gertler, *F-35 Joint Strike Fighter (JSF) Program*, (Washington, DC: Library of Congress, Congressional Research Service, 2014): 1–3; http://digital.library.unt.edu/ark:/67531/metadc306493/m1/1/high_res_d/RL30563_2014Apr29.pdf; Accessed April 27, 2017.
3. See Ibid., 50; "Lightning Rod: F-35 Fighter Family Capabilities and Controversies," *Defense Industry Daily*, (April 23, 2015): 3; http://www.defenseindustrydaily.com/lightning-rod-f-35-fighter-family-capabilities-and-controversies-021922/; Accessed April 27, 2017; and Doug Hayward, *F-35 Weapon System Overview*, (Fort Worth: Lockheed Martin, 2010); http://docplayer.net/25354666-F-35-weapon-system-overview.html; Accessed April 27, 2017.
4. Paul M. Bevilacqua, "Genesis of the F-35 Joint Strike Fighter," *Journal of Aircraft*, 46 (6)(November–December 2009): 1833; https://doi.org/10.2514/1.42903.
5. See Ibid., 1833; and U.S. Department of Defense, *Report on the Bottom-Up Review*, (Washington, DC: DOD, 1993): 35–38; http://babel.hathitrust.org/cgi/pt?id=uc1.32106010456157;view=1up;seq=48; Accessed April 28, 2017.

6. U.S. Office of the Undersecretary of Defense For Acquisition & Technology, *Report of the Defense Science Board Task Force on the Joint Advanced Strike Technology (JAST) Program*, (Washington, DC: Defense Science Board, 1994): ES-2; http://www.dtic.mil/dtic/tr/fulltext/u2/a292094.pdf; Accessed April 28, 2017.
7. Ibid., ES-3.
8. Bevilacqua, 1834.
9. Ibid., 1835.
10. U.S. General Accounting Office, *Combat Air Power: Joint Assessment of Air Superiority Can Be Improved*, (Washington, DC: GAO, 1997): 7–8; http://www.gao.gov/assets/160/155769.pdf; Accessed April 28, 2017.
11. See Gertler, 4; and *National Defense Authorization Act for Fiscal Year 1996: Conference Report to Accompany S. 1124*, House Report 104-450, (Washington, DC: GPO, 1996): 706.
12. U.S. Congress, Senate Committee on Appropriations, *Department of Defense Appropriations for Fiscal Year 1999*, (Washington, DC: GPO, 1998): 47, 55.
13. Ibid., 124–126.
14. Ibid., *Department of Defense Appropriations for Fiscal Year 2000*, (Washington, DC: GPO, 1999): 147.
15. Ibid., 455; and U.S. Congressional Budget Office, *CBO Testimony: Statement of Christopher Jehn on Modernizing Tactical Aircraft before the Subcommittee on Airland, Senate Armed Services Committee*, (Washington, DC: CBO, March 10, 1999): 3–4; http://www.cbo.gov/sites/default/files/031099.pdf; Accessed April 28, 2017.
16. U.S. Congress, House Committee on Government Reform, Subcommittee on National Security, Veterans Affairs, and International Relations, *F-22 Cost Controls*, (Washington, DC: GPO, 2000): 99; http://purl.access.gpo.gov/GPO/LPS7076; Accessed April 28, 2017.
17. U.S. Congressional Budget Office, *Budget Options*, (Washington, DC: CBO, 2000): 79; http://www.cbo.gov/sites/default/files/wholereport_0.pdf; Accessed April 28, 2017.
18. See U.S. General Accounting Office, *Joint Strike Fighter Acquisition: Development Schedule Could be Changed to Reduce Risks*, (Washington, DC: GAO, 2000): 2–3; http://www.gao.gov/assets/110/108316.pdf; Accessed April 28, 2017; and U.S. Congress, House Committee on Government Reform, Subcommittee on National Security, Veterans Affairs, and International Relations, *Joint Strike Fighter Acquisition Reform: Will It Fly?*, (Washington, DC: GPO, 2000): 5–9; http://purl.access.gpo.gov/GPO/LPS13019; Accessed April 28, 2017.
19. GAO, *Joint Strike Fighter Acquisition: Development Schedule Could be Changed to Reduce Risks*, 16.

20. Lockheed Martin, *History: F-35 Program Timeline*, (Fort Worth: Lockheed Martin, 2015): 1; https://www.f35.com/about/history; Accessed April 29, 2017.
21. U.S. Department of Defense, *Briefing on the Joint Strike Fighter Contract Announcement*, (Washington, DC: DOD, October 26, 2001): 1–5; http://www.defense.gov/utility/printitem.aspx?print=http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=2186; Accessed April 29, 2017. For the webcast of this announcement see CSPAN, "Joint Strike Fighter Program, (October 26, 2001): http://www.c-span.org/video/?166956-1/joint-strike-fighter-program; Accessed April 30, 2017.
22. Ibid., *Contracts: No. 544-01*, (Washington, DC: DOD, October 26, 2001): 1; http://www.defense.gov/Contracts/Contract.aspx?ContractID=2131; Accessed April 29, 2017.
23. *History: F-35 Program Timeline*.
24. U.S. Congress, Senate Committee on Armed Services, *Department of Defense's Quadrennial Defense Review (QDR)*, (Washington, DC: GPO, 2002): 117–118; http://purl.fdlp.gov/GPO/gpo46358; Accessed April 29, 2017.
25. Ibid., *The Future of the North Atlantic Treaty Organization (NATO)*, (Washington, DC: GPO, 2002): 27.
26. U.S. Congress, House Committee on Small Business, *Pentagon's Procurement Policies With Respect to Small Business*, (Washington, DC: GPO, 2002): 18; http://purl.access.gpo.gov/GPO/LPS15167; Accessed April 29, 2017.
27. U.S. Congress, House Committee on Government Reform, Subcommittee on National Security, Emerging Threats, and International Relations, *Controlling Costs in Tactical Aircraft Programs*, (Washington, DC: GPO, 2003): 181; http://purl.access.gpo.gov/GPO/LPS40567; Accessed April 29, 2017. Hearing webcast on CSPAN at http://www.c-span.org/video/?177486-1/joint-strike-fighter-program; Accessed April 30, 2017.
28. Ibid. *Is DOD Meeting Joint Strike Fighter [JSF] International Cooperative Program Goals?*, (Washington, DC: GPO, 2004): 1.
29. U.S. General Accounting Office, *Joint Strike Fighter Acquisition: Cooperative Program Needs Greater Oversight to Ensure Goals are Met*, (Washington, DC: GAO, 2003): 2–3; http://www.gao.gov/new.items/d03775.pdf; Accessed April 20, 2017.
30. U.S. Congress, Senate Committee on Armed Services, *Department of Defense Authorizations for Fiscal Year 2005: Part 1*, (Washington, DC: GPO, 2005): 63–64; http://www.gpo.gov/fdsys/pkg/CHRG-108shrg93571/pdf/CHRG-108shrg93571.pdf; Accessed April 29, 2017.

31. U.S. Congress, Senate Committee on Appropriations, Subcommittee on Defense, *Department of Defense Appropriations For Fiscal Year, 2005*, (Washington, DC: GPO, 2004): 212; http://purl.access.gpo.gov/GPO/LPS58231; Accessed April 30, 2017.
32. Stephen G. DiDomenico, *International Armament Cooperative Programs: Benefits, Liabilities, and Self-Inflicted Wounds-The JSF as a Case Study*, (Maxwell Air Force Base, AL: Air University Press, 2006): 14–16, 19–22, 34, 36, 39–41; http://purl.access.gpo.gov/GPO/LPS102741; Accessed April 30, 2017.
33. Ibid., 53–54.
34. Ibid., 54.
35. See Public Law 94-106, "Department of Defense Appropriations Authorization Act, 1976," 89 *U.S. Statutes at Large* 539; and Irv Blickstein, Charles Nemfakos, and Jerry M. Sollinger, "Digging Out the Root Cause: Nunn-McCurdy Breaches in Major Defense Acquisition Programs," *Defense Acquisition Research Journal,* 20 (2)(July 2013): 129; http://www.dau.mil/publications/DefenseARJ/ARJ/ARJ66/ARJ_66-Blickstein.pdf' Accessed April 30, 2017.
36. See Blickstein, 129; and Public Law 97-86, "Department of Defense Authorization Act, 1982," 95 *U.S. Statutes at Large*, 1129–1132.
37. Public Law 97-252, "Department of Defense Authorization Act, 1983," 96 *U.S. Statutes at Large*, 741–746.
38. See Blickstein, 129; and Public Law 109-163, "National Defense Authorization Act for Fiscal Year 2006," 119 *U.S. Statutes at Large*, 3367–3370.
39. U.S. Congress, House Committee on the Budget, *National and Homeland Security: Meeting Our Needs*, (Washington, DC: GPO, 2005): 35–36; http://purl.access.gpo.gov/GPO/LPS60598; Accessed April 30, 2017.
40. See U.S. Congress, House Committee on Armed Services, *Issues Relating to Defense Acquisition Reform*, (Washington, DC: GPO, 2007): 16; http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg32970/pdf/CHRG-109hhrg32970.pdf; Accessed April 30, 2017; and Public Law 101-510, "National Defense Authorization Act for Fiscal Year 1991," 104 *U.S. Statutes at Large*, 1638–1667.
41. *History: F-35 Program Timeline.*
42. GAO, *Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program With Different Acquisition Strategy*, (Washington, DC: GAO, 2005): 2–4; www.gao.gov/assets/245629.pdf; Accessed April 30, 2017.

43. Ibid., *Defense Acquisitions: Assessments of Selected Major Weapons Programs*, (Washington, DC: GAO, 2005): 79; www.gao.gov/assets/250/245884.pdf; Accessed April 30, 2017.
44. Ibid., *Joint Strike Fighter: DOD Plans to Enter Production Before Testing Demonstrates Acceptable Performance*, (Washington, DC: GAO, 2006): 2–4; www.gao.gov/assets/250/249301.pdf; Accessed April 30, 2017.
45. Ibid., *Joint Strike Fighter: Progress Made and Challenges Remain*, (Washington, DC: GAO, 2007): 2–3; www.gao.gov/assets/260/257628.pdf; Accessed April 30, 2017.
46. Ibid., *Defense Acquisitions: Analysis of Costs for the Joint Strike Fighter Engine Program: Statement of Michael Sullivan*, (Washington, DC: GAO, March 22, 2007): 1–2; www.gao.gov/assets/120/116016.pdf; Accessed April 30, 2017.
47. U.S. Congress, House Committee on Armed Services, Subcommittees on Air and Land Forces and Seapower and Expeditionary Forces, *Hearing on National Defense Authorization Act for Fiscal Year 2008 and Oversight of Previously Authorized Programs: Budget Request on Department of Defense Aircraft Programs*, (Washington, DC: GPO, 2009): 184; http://purl.access.gpo.gov/GPO/FDLP133; Accessed April 29, 2017; and Gertler, *F-35 Alternate Engine Program: Background and Issues for Congress*, (Washington, DC: Library of Congress, Congressional Research Service, 2012): 4; http://www.fas.org/sgp/crs/weapons/R41131.pdf; Accessed April 30, 2017.
48. U.S. Congress, House Committee on Armed Services, *Hearing on National Defense Authorization Act for Fiscal Year 2009 and Oversight of Previously Authorized Programs: Budget Request From the Department of the Navy*, (Washington, DC: GPO, 2009): 42; http://purl.access.gpo.gov/GPO/FDLP145; Accessed May 1, 2017.
49. U.S. Congress, House Committee on Appropriations, Subcommittee on Defense, *Department of Defense Appropriations for 2009*, (Washington, DC: GPO, 2009): 266–267; http://purl.access.gpo.gov/GPO/LPS110514; Accessed May 1, 2017.
50. GAO, *Defense Acquisitions: Significant Challenges Ahead in Developing and Demonstrating Future Combat System's Network and Software*, (Washington, DC: GAO, 2008): 17; www.gao.gov/assets/280/273386.pdf; Accessed May 1, 2017.
51. Ibid., *Joint Strike Fighter: Recent Decisions by DOD Add to Program Risk*, (Washington, DC: GAO, 2008): 2–3; www.gao.gov/assets/280/273563.pdf; Accessed May 1, 2017.
52. Ibid., 12.
53. Ibid., 15.

54. See Conor Duffy, *"Australian Fighter Jets Inferior,"* (Sydney: Australian Broadcasting Corporation, September 24, 2008): 1–3; http://www.abc.net.au/lateline/content/2008/s2373457.htm; Accessed May 1, 2017; See webcast at http://www.abc.net.au/reslib/200809/r296075_1274202.asx; Accessed May 1, 2017; and Leigh Sales, *Joel Fitzgibbon Joins Lateline*. (Sydney: Australian Broadcasting Corporation, September 24, 2008): 1–5; http://www.abc.net.au/lateline/joel-fitzgibbon-joins-lateline/521598; Accessed December 21, 2017; for Australian Defence Minister Joel Fitzgibbon's response to this Rand Corporation analysis.
55. "Statement Regarding Media Coverage of F-35 Joint Strike Fighter," (Santa Monica: Rand Corporation, September 25, 2008): 1; http://www.rand.org/news/press/2008/09/25.html; Accessed May 1, 2017.
56. *History: F-35 Program Timeline*, Accessed May 1, 2015.
57. *Congressional Record*, 155 (69)(May 6, 2009): S5209, S5211; https://www.govinfo.gov/content/pkg/CREC-2009-05-06/pdf/CREC-2009-05-06.pdf; Accessed December 21, 2017.
58. See Public Law 111-23. "Weapons System Acquisition Reform Act of 2009." 123 *U.S. Statutes at Large*, 1704–1733; and U.S. Congress, Senate Committee on Armed Services, *Acquisition of Major Weapons Systems by the Department of Defense and S. 454, the Weapons System Acquisition Reform Act of 2009*, (Washington, DC: GPO, 2009): http://purl.access.gpo.gov/GPO/LPS117925; Accessed May 4, 2017.
59. GAO, *Weapons Acquisition Reform: Reform Act is Helping DOD Acquisition Programs Reduce Risk, but Implementation Challenges Remain*, (Washington, DC: GAO, 2012): 14–29; http://www.gao.gov/assets/660/650908.pdf; Accessed May 4, 2017.
60. See *Congress and the Nation 2009–2012: Politics and Policy in the 111th and 112th Congress*, David R. Tarr, ed., (Washington, DC: Sage Publications, 2014): 277, 281; and Public Law 111-84, *National Defense Authorization Act for Fiscal Year 2010*, 123 *U.S. Statutes at Large*, 2238–2239, 2734, 2767, 2772.
61. U.S. Congressional Budget Office, *Alternatives for Modernizing U.S. Fighter Forces*, (Washington, DC: CBO, 2009): 25–44; esp. 28–29; http://purl.access.gpo.gov/GPO/LPS116409; Accessed May 5, 2017.
62. Gertler, 28–29.
63. See Ibid., 30–31; and "DOD News Briefing With Secretary Gates and Admiral Mullen from the Pentagon," (Washington, DC: DOD, January 6, 2011): 3; http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4747; Accessed May 4, 2017.
64. "Panetta Lifts F-35 Fighter Variant Probation," (Washington, DC: DOD, January 20, 2012): 1; http://archive.defense.gov/news/newsarticle.aspx?id=66879; Accessed May 4, 2017.

65. U.S. National Commission on Fiscal Responsibility and Reform, "200 Billion in Illustrative Savings," (Washington, DC: The Commission, November 12, 2010): 18–19; http://www.fiscalcommission.gov/sites/fiscalcommission.gov/files/documents/Illustrative_List_11.10.2010.pdf; Accessed May 4, 2017.
66. Public Law 112-25, "Budget Control Act of 2011," 125 *U.S. Statutes at Large*, 240–267.
67. Jim Garemone, "Panetta Tells Senators Sequestration Would Devastate DOD," (Washington, DC: DOD, November 15, 2011): 1; http://www.defense.gov/news/newsarticle.aspx?id=66094; Accessed May 4, 2017.
68. U.S. Congress, Senate Committee on Armed Services, Subcommittee on Airland, *Department of Defense Authorization for Appropriations for Fiscal Year 2014 and the Future Years Defense Program: Part 4 Airland*, (Washington, DC: GPO, 2014): 10–11; http://purl.fdlp.gov/GPO/gpo46909; Accessed May 4, 2017.
69. See Public Law 112-81, "National Defense Authorization Act for Fiscal Year 2012," 125 *U.S. Statutes at Large* 1325, and Tarr, 304.
70. Public Law 112-239, "National Defense Authorization Act for Fiscal Year 2013," 126 *U.S. Statutes at Large* 2237, 2261.
71. Public Law 113-66, "National Defense Authorization Act for Fiscal Year 2014," 127 *U.S. Statutes at Large* 1093, 1115.
72. Public Law 113-201, "Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015," 128 *U.S. Statutes at Large* 3915, 3939.
73. U.S. Department of Defense, Office of the Undersecretary of Defense (Comptroller) CFO, *Program Acquisition Cost by Weapons System: Fiscal Year 2016 Budget Request*, (Washington, DC: DOD, 2015): 1–6; http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2016/FY2016_Weapons.pdf; Accessed May 4, 2017.
74. U.S. Congress, House Committee on Natural Resources, Subcommittee on Energy and Mineral Resources, *Strategic and Critical Minerals Policy: Domestic Minerals Supplies and Demands in a Time of Foreign Supply Disruptions*, (Washington, DC: GPO, 2011): 33–36; http://purl.fdlp.gov/GPO/gpo15613; Accessed May 4, 2017.
75. U.S. Congress, Senate Committee on Armed Services, *Department of Defense Authorization for Appropriations for Fiscal Year 2013 and the Future Years Defense Program*, (Washington, DC: GPO, 2013): 1:259; http://purl.fdlp.gov/GPO/gpo34177; Accessed May 4, 2017.
76. U.S. Congress, House Committee on Armed Services, *Hearing on National Defense Authorization Act for Fiscal Year 2014 and Oversight of Previously Authorized Programs: Budget Request from the Department of*

Defense, (Washington, DC: GPO, 2013): 7; http://purl.fdlp.gov/GPO/gpo41321; Accessed May 4, 2017.

77. See U.S. Congress, Senate Committee on Appropriations, Subcommittee on Defense, *Department of Defense Appropriations for Fiscal Year 2014*, (Washington, DC: GPO, 2013): 10; http://www.gpo.gov/fdsys/pkg/CHRG-113shrg39104549/pdf/CHRG-113shrg39104549.pdf; Accessed May 4, 2017; and webcast from CSPAN at http://www.c-span.org/video/?313451-1/sen-subcmte-debates-joint-strike-fighter-system; 10:10–11:00, Accessed May 4, 2017.
78. Ibid., 13; webcast at Ibid., 14:35–15:24.
79. Ibid., 16; webcast at Ibid., 16:42–17:16.
80. Ibid., 27, 29–30, 34.
81. U.S. Congress, House Committee on Armed Services, *Initial Conclusions Formed by the Defense Strategic Choices and Management Review*, (Washington, DC: GPO, 2013): 99; http://purl.fdlp.gov/GPO/gpo42204; Accessed May 4, 2017.
82. U.S. Congress, House Committee on Appropriations, Subcommittee on Defense, *Department of Defense Appropriations for 2015*, (Washington, DC: GPO, 2015): 45, 185, http://purl.fdlp.gov/GPO/gpo54960; Accessed May 5, 2017.
83. See U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *National Defense Authorization Act for Fiscal Year 2015 and Oversight of Previously Authorized Programs: Fiscal Year 2015 Navy, Marine Corps, and Air Force Combat Aviation Programs*, (Washington, DC: GPO, 2014): 1–5; http://www.gpo.gov/fdsys/pkg/CHRG-113hhrg87858/pdf/CHRG-113hhrg87858.pdf; Accessed May 5, 2017; and CSPAN Archive, http://www.c-span.org/video/?318509-1/fy2015-combat-aviation-programs-budget; 11:13–12:17 features Bogdan's comments; Accessed May 5, 2017.
84. U.S. Congress, Senate Committee on Appropriations, Subcommittee on Defense, *Department of Defense Appropriations for Fiscal Year 2015*, (Washington, DC: GPO, 2015): 60; http://www.gpo.gov/fdsys/pkg/CHRG-113shrg49104595/pdf/CHRG-113shrg49104595.pdf; Accessed May 5, 2017.
85. See "Statement of Admiral William E. Gortney, United States Navy Commander United States Northern Command and North American Aerospace Defense Command Before the Senate Armed Services Committee," (Washington, DC: Senate Armed Services Committee, March 12, 2015): 5; http://www.armed-services.senate.gov/imo/media/doc/Gortney_03-12-15.pdf; Accessed May 5, 2017; Ibid., *Department of Defense Authorization for Appropriations for Fiscal Year 2016 and the Future Years Defense Program: Part 2: Seapower*,

(Washington, DC: GPO: 2015): 123; http://purl.fdlp.gov/GPO/gpo67057; Accessed June 4, 2018 and U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Statement of the Hon. Sean J. Stackley Assistant Secretary of the Navy (Research, Development, and Acquisition) and Lt. General Christopher Bogdan, Program Executive Officer F-35*, (Washington, DC: Senate Armed Services Committee, March 5, 2015): 2–5; http://docs.house.gov/meetings/AS/AS25/20150414/103032/HHRG-114-AS25-Wstate-BogdanC-20150414.pdf; Accessed May 5, 2017.

86. U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Update on the F-35 Joint Strike Fighter Program*, (Washington, DC: GPO, 2016): 3; http://purl.fdlp.gov/GPO/gpo68712; (Accessed February 13, 2017).
87. Ibid., 21.
88. *Congressional Record*, 162 (63)(April 25, 2016): S2404–2405; https://www.govinfo.gov/content/pkg/CREC-2016-04-25/pdf/CREC-2016-04-25.pdf; (Accessed February 13, 2017).
89. U.S. Congress, Senate Committee on Appropriations, *Department of Defense Appropriations Bill, 2017*, Senate Report 114-263, (Washington, DC: GPO, May 26, 2016): 8–9; https://www.govinfo.gov/content/pkg/CRPT-114sprt263/pdf/CRPT-114srpt263.pdf; Accessed February 8, 2017.
90. U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Military Services Fifth Generation Tactical Aircraft Challenges and F-35 Joint Strike Fighter Program Update*, (Washington, DC: House Armed Services Committee, 2017): 44–47; http://purl.fdlp.gov/GPO/gpo85874; Accessed May 31, 2018.
91. Ibid., 48–54.
92. Ibid., 18, 25, 61–71.
93. Ibid., 97–98.
94. See *F-35 Program Timeline*, Accessed May 5, 2017, F-35 Lightning II: Lockheed Martin, "Development of F-35 3i Software for USAF IOC Complete," (May 9, 2016): 1–2; https://www.f35.com/news/detail/development-of-f-35-3i-software-for-usaf-ioc-complete; (Accessed June 1, 2018); Ibid., "Air Force Declares the F-35A Combat Ready," (August 2, 2016): 1–2; https://www.f35.com/news/detail/air-force-declares-the-F-35a-combat-ready; Accessed February 13, 2017.
95. Ibid., "F-35C Back at Sea for Third Round of Carrier Tests," (August 17, 2016): 1–2; https://www.f35.com/news/detail/f-35c-back-at-sea-for-3rd-round-of-carrier-tests; Accessed February 13, 2017; Ibid.,

"F-35 Helmet, Ahead of Our Time, (November 4, 2016): 4–6; https://www.f35.com/news/detail/f-35-helmet-ahead-of-our-time; Accessed June 1, 2018; and Ibid., "Agreement Reached on Lowest Priced F-35s in Program History," (February 3, 2017): 4–7; Accessed February 13, https://www.f35.com/news/detail/agreement-reached-on-lowest-priced-f-35s-in-program-history; (Accessed June 1, 2018.).

96. Donald J. Trump, "The F-35 Program and Cost is Out of Control," (December 12, 2016): https://twitter.com/realDonaldTrump/status/808301935728230404; Accessed February 13, 2017.
97. U.S. Department of Defense, Office of Inspector General, *Export Controls: Controls Over the Export of Joint Strike Fighter Technology*, (Washington, DC: DODIG, 2006): 8–9; https://media.defense.gov/2006/Jan/11/2001712075/-1/-1/1/D-2006-044.pdf. Accessed August 14, 2018.
98. Ibid., *Quality Assurance Assessment of the F-35 Lightning II Program*, (Washington, DC: DODIG, 2013): i; https://media.defense.gov/2013/Sep/30/2001713313/-1/-1/1/DODIG-2013-140.pdf; Accessed August 14, 2018; Accessed May 5, 2017.
99. See Ibid., *F-35 Lightning II Program Quality Assurance and Corrective Action Evaluation*, (Washington, DC: DODIG, 2015): i; https://media.defense.gov/2015/Mar/11/2001713476/-1/-1/1/DODIG-2015-092.pdf; Accessed August 14, 2018; and Public Law 108-136, "National Defense Authorization Act for Fiscal Year 2004," 117 *U.S. Statutes at Large*, 1540–1541.
100. U.S. Department of Defense, Director of Operational Test and Evaluation, *FY 2016 Annual Report*, (Washington, DC: DOD, 2017): 47; http://www.dote.osd.mil/pub/reports/FY2016/pdf/other/2016DOTEAnnualReport.pdf; Accessed February 16, 2017.
101. GAO, *F-35 Joint Strike Fighter Program: Restructuring Has Improved the Program, but Affordability Challenges and Other Risks Remain*, (Washington, DC: GAO, 2013): 2–5; http://www.gao.gov/assets/660/655295.pdf; Accessed May 5, 2017.
102. Ibid., 7–10.
103. Ibid., *Sequestration: Observations on the Department of Defense's Approach in Fiscal Year 2013*, (Washington, DC: GAO, November 7, 2013): 37; http://www.gao.gov/assets/660/655295.pdf; Accessed May 5, 2017.
104. Ibid., *F-35 Joint Strike Fighter: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities*, (Washington, DC: GAO, 2013): 1–3, 5–9, 23; http://www.gao.gov/assets/670/661842.pdf; Accessed May 5, 2017.

105. Ibid., *F-35 Joint Strike Fighter: Observations on Program Progress*, (Washington, DC: GAO, April 14, 2015): 1–6; http://www.gao.gov/assets/670/669605.pdf; Accessed May 5, 2017.
106. Michael J. Sullivan, *F-35 Joint Strike Fighter: Preliminary Observations on Program Progress*, (Washington, DC: GAO, 2016): 4; http://www.gao.gov/assets/680/676012.pdf; Accessed February 13, 2017.
107. Ibid., 6–7.
108. Ibid., 9.
109. Ibid., 11–12.
110. GAO, *Weapons Systems Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success*, (Washington, DC: GAO, 2016): 21–22; http://www.gao.gov/assets/690/681106.pdf; Accessed February 14, 2017.
111. Ibid., *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency*, (Washington, DC: GAO, 2017): 12–20; https://www.gao.gov/assets/690/687982.pdf; Accessed December 20, 2017.
112. Ibid., 32–33.
113. Ibid., 39–40.
114. See Mark A. Lorell, Michael Kennedy, et al., *Do Joint Fighter Programs Save Money?*, (Santa Monica: Rand Corporation, 2013): xii–xiv; http://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1225/RAND_MG1225.pdf; Accessed May 6, 2017; and U.S. Air Force, "General Janet C. Wolfenbarger," (Washington, DC: U.S. Air Force, 2015): 1–2; http://www.af.mil/AboutUs/Biographies/Display/tabid/225/Article/107934/general-janet-c-wolfenbarger.aspx; Accessed June 1, 2018.
115. Ibid., xv.
116. See Ibid., xvi; and *International Military Aerospace Collaboration: Case Studies in Domestic and Intergovernmental Politics*, Pia Christina Wood and Davis S. Sorenson, eds., (Aldershot, UK: Ashgate, 2000).
117. Ibid., xvii.
118. See Ibid., xviii, Bruce G Linster, Stephen Slate, and Robert L. Waller, "Consolidation of the U.S. Defense Industrial Base: Impact on Research Expenditures," *Acquisition Review Quarterly*, 9 (2)(Spring 2002): 143–149; http://webharvest.gov/peth04/20041019074635/http://www.dau.mil/pubs/arq/2002arq/SlateSP2.pdf; Accessed May 6, 2017.
119. Ibid., xviii–xix.
120. U.S. Department of Defense, Office of the Undersecretary of Defense Acquisitions, Technology, and Logistics, *Selected Acquisition Report (SAR) Summary Tables as of December 31, 2014*, (Washington, DC:

DOD, 2015): 6; http://www.acq.osd.mil/ara/sar/SST-2014-12.pdf; Accessed May 6, 2017.
121. Ibid.
122. Lockheed Martin, *F-35 Lightning II: Domestic Impact*, https://www.f35.com/about/economic-impact-map; Accessed June 1, 2018.
123. William D. Hartung, *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft*, (Washington, DC: Center for International Policy, 2014): 10–18; http://www.ciponline.org/images/uploads/publications/Hartung_IPR_0114_F-35_Promising_the_Sky_Updated.pdf; Accessed June 1, 2018.
124. Center for Responsive Politics, *OpenSecrets.org: Congressional Races*, (Washington, DC: Center for Responsive Politics, 2016): http://www.opensecrets.org/races/; Accessed June 1, 2018.
125. Ibid., Accessed May 11, 2017.
126. Congresswoman Kay Granger, "Granger/Dicks Announce Joint Strike Fighter Caucus," (Washington, DC: Rep. Kay Granger, November 9, 2011): 1–2; https://kaygranger.house.gov/press-release/granger-dicks-announce-congressional-joint-strike-fighter-caucus; Accessed June 1, 2018. For examples of scholarly literature on congressional caucuses see Susan Webb Hammond, "Congressional Caucuses and Party Leaders in the House of Representatives," *Political Science Quarterly*, 106 (Summer 1991): 277–294; Scott L. Kastner and Douglas B. Grob, "Legislative Foundations of U.S.-Taiwan Relations: A New Look at the Congressional Taiwan Caucus," *Foreign Policy Analysis*, 5 (1)(January 2009): 57–72; https://doi.org/10.1111/j.1743-8594.2008.00083.x; and Kristina C. Miler, "The Constituency Motivations of Caucus Membership," *American Politics Research*, 39 (5)(September 2011): 885–920; https://doi.org/10.1177/1532673X11407148.
127. David Martin, "Is the F-35 Worth It?," (New York: *CBS News, 60 Minutes*, February 16, 2014): 1–3; http://www.cbsnews.com/news/f-35-joint-strike-fighter-60-minutes/; Accessed May 11, 2017.
128. See *National Defense Authorization Act for Fiscal Year 2015 and Oversight of Previously Authorized Programs: Fiscal Year 2015 Navy, Marine Corps, and Air Force Combat Aviation Programs*, 1–5; and *60 Minutes*, 4; Schmidle quote and supplemental info at 6:17–7:45.
129. Ibid., 4–7.
130. U.S. Congress, House Committee on Homeland Security, Subcommittee on Oversight, Investigations, and Management, *America is Under Cyber Attack: Why Urgent Action is Needed*, (Washington, DC: GPO, 2013): 15; http://purl.fdlp.gov/GPO/gpo34535; Accessed May 11, 2017; U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations, *Cyber Espionage and the Theft of*

U.S. Intellectual Property and Technology, (Washington, DC: GPO, 2014): 23; http://purl.fdlp.gov/GPO/gpo47093; Accessed May 11, 2017; and Michael W. Pietrucha, "The Comanche and the Albatross About Our Neck Was Hung," *Air and Space Power Journal*, 28 (3)(May–June 2014): 136; http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2014-May-Jun/F-Pietrucha.pdf?source=GovD; Accessed May 11, 2017.

131. See "Vice-Admiral Mathias W. Winter Director, Joint Strike Fighter Program, Office of the Secretary of Defense, (Washington, DC: U.S. Navy, June 9, 2017): 1–2; http://www.navy.mil/navydata/bios/navybio.asp?bioID=578; Accessed December 20, 2017; "F-35C Integration into the Fleet," (Washington, DC: JST Joint Program Office, August 3, 2017): 1–3; http://www.jsf.mil/news/docs/20170803_F-35C_Integration_into_the_Fleet.pdf; Accessed December 20, 2017; Ibid., "USS Lincoln Test F-35C Lightning II at Sea," (September 11, 2017): 1–2; http://www.jsf.mil/news/docs/20170912_USS_Lincoln_Tests_F35C_Lightning_II_at_SEa.pdf; Accessed December 20, 2017; and Ibid., "F-35 Exiting the Pattern: At Long Last, the F-35 Strike Fight Fighter Set to Complete Development Phase," (December 18, 2017): 1–3; http://www.jsf.mil/news/docs/20171218_F35_Exiting_the_Pattern.pdf; Accessed December 20, 2017.
132. *National Defense Authorization Act for Fiscal Year 2018*, (Senate Report 115-125): Washington, DC: GPO, 2017): 116–117; https://purl.fdlp.gov/GPO/gpo82611; Accessed December 20, 2017.
133. U.S. Congress, House Committee on Armed Services, *Aviation Readiness: What's the Flight Plan*, (Washington, DC: House Armed Services Committee, 2017): 6; http://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Bio-RudderS-20171109.pdf; Accessed June 1, 2018; and Ibid., *Military Aviation Readiness and Safety Hearing*; http://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Wstate-NowlandC-20171109.pdf; Accessed June 1, 2018.
134. U.S. Congress, Senate Committee on Armed Services. "John S. McCain National Defense Authorization Act for Fiscal Year 2019," (Washington, DC: Senate Committee on Armed Services, May 24, 2018): 1, 8–9; https://www.armed-services.senate.gov/download/fy19-ndaa-summary; Accessed June 4, 2018.
135. See President of the United States, *National Security Strategy of the United States of America*, (Washington, DC: The White House 2017): https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905-2.pdf; Accessed December 20, 2017; U.S. Department of Defense, Manufacturing and Industrial Base Policy, *Annual Industrial Capabilities Report to Congress*, (Washington, DC: DOD, 2017):

http://www.businessdefense.gov/Portals/51/Documents/Resources/2017%20AIC%20RTC%2005-17-2018%20-%20Public%20Release.pdf?ver=2018-05-17-224631-340; Accessed June 1, 2018; Ibid., *Summary of the 2018 National Defense Strategy*, (Washington, DC: DOD, 2018): https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf; Accessed June 1, 2018; Ibid., *2018 Nuclear Posture Review*, (Washington, DC: DOD, 2018): https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF; Accessed June 1, 2018; James Z. Przystup and Phillip C. Saunders, *Asia and the Trump Administration: Challenges, Opportunities, and a Road Ahead*, (Washington, DC: National Defense University Press, 2017); http://ndupress.ndu.edu/Media/News/Article/1271523/asia-and-the-trump-administration-challenges-opportunities-and-a-road-ahead/; Accessed December 20, 2017; Wayne A. Schroeder, "The Future U.S. Defense Budget, *Orbis*, 61 (1) (Winter 2017): 64–75: https://doi.org/10.1016/j.orbis.2016.12.003; and Robert P. Haffa, "Defense Decisions for the Trump Administration," *Strategic Studies Quarterly*, 11 (1)(Spring 2017): 25–48; http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-11_Issue-1/Haffa.pdf; Accessed December 20, 2017; and "Marine Corps F-35B Conducts Combat Strikes in Afghanistan," (Washington, DC: Department of Defense, September 28, 2018): 1–2; https://dod.defense.gov/News/Article/Article/1647694/marine-corps-f-35b-conducts-combat-strikes-in-afghanistan/; Accessed October 10, 2018.

References

Bevilacqua, Pau M. "Genesis of the F-35 Joint Strike Fighter." *Journal of Aircraft*, 46 (6) (November–December 2009): 1833. https://doi.org/10.2514/1.42903.

Blickstein, Irv, Charles Nemfakos, and Jerry M. Sollinger. "Digging Out the Root Cause: Nunn-McCurdy Breaches in Major Defense Acquisition Programs." *Defense Acquisition Research Journal*, 20 (2) (July 2013): 129. http://www.dau.mil/publications/DefenseARJ/ARJ/ARJ66/ARJ_66-Blickstein.pdf. Accessed April 30, 2017.

Brannon, Shannon A. *Providing the Means of War: Historical Perspectives on Defense Acquisition, 1945–2000.* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2005). http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMHPub70-87-1ProvidingtheMeans.pdf. Accessed April 27, 2017.

Center for Responsive Politics. *OpenSecrets.org: Congressional Races* (Washington, DC: Center for Responsive Politics, 2016). http://www.opensecrets.org/races. Accessed June 1, 2018.

Congress and the Nation 2009–2012: Politics and Policy in the 111th and 112th Congress. Edited by David R. Tarr (Washington, DC: Sage Publications, 2014): 277, 281.

Congressional Record. 155 (69) (May 6, 2009): S5209, S5211. https://www.govinfo.gov/content/pkg/CREC-2009-05-06/pdf/CREC-2009-05-06.pdf. Accessed December 21, 2017.

———. 162 (63) (April 25, 2016): S2404-S2405. https://www.govinfo.gov/content/pkg/CREC-2016-04-25/pdf/CREC-2016-04-25.pdf. (Accessed February 13, 2017).

Converse III, Elliot V. *Acquisition History Volume I: Rearming for the Cold War, 1945–1960* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2012). http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol1.pdf. Accessed April 27, 2017.

CSPAN. "Joint Strike Fighter Program." (October 26, 2001). http://www.c-span.org/video/?166956-1/joint-strike-fighter-program. Accessed April 30, 2017.

———. "Joint Strike Fighter Program." (July 21, 2003). https://www.c-span.org/video/?177486-1/joint-strike-fighter-program. Accessed April 30, 2017.

———. "Joint Strike Fighter Program." (June 19, 2013). https://www.c-span.org/video/?313451-1/sen-subcmte-debates-joint-strike-fighter-system. Accessed May 4, 2017.

———. "Joint Strike Fighter Program." "Joint Strike Fighter and Combat Aviation Programs." (March 26, 2014). https://www.c-span.org/video/?318509-1/fy2015-combat-aviation-programs-budget. Accessed May 5, 2017.

DiDomenico, Stephen G. *International Armament Cooperative Programs: Benefits, Liabilities, and Self-Inflicted Wounds-The JSF as a Case Study*. (Maxwell Air Force Base, AL: Air University Press, 2006): 14–16, 19–22, 34, 36, 39–41. http://purl.access.gpo.gov/GPO/LPS102741. Accessed April 30, 2017.

Duffy, Conor. "Australian Fighter Jets Inferior." (Sydney: Australian Broadcasting Corporation, September 24, 2008): 1–3. http://www.abc.net.au/lateline/content/2008/s2373457.htm. Accessed May 1, 2017.

"F-35 Exiting the Pattern: AT Long Last, the F-35 Strike Fighter Set to Complete Development Phase." (December 18, 2017): 1–3. http://www.jsf.mil/news/docs/20171218_F35_Exiting_the_Pattern.pdf. Accessed December 20, 2017.

"F-35C Integration into the Fleet." (Washington, DC: JSF Joint Program Office, August 3, 2017): 1–3. http://www.jsf.mil/news/docs/20170803_F-35CF-35C_Integration_into_the_Fleet.pdf. Accessed December 20, 2017.

Fox, J. Ronald. *Defense Acquisition Reform, 1960–2009: An Elusive Goal* (Washington, DC: United States Army Center for Military History, 2011). http://history.defense.gov/Portals/Documents/acquisition_pub/CMH_pub_51-3-1.pdf. Accessed April 27, 2017.

Garemone, Jim. "Panetta Tells Senators Sequestration Would Devastate DOD." (Washington, DC: DOD, November 15, 2011): 1. http://archive.defense.gov/news/newsarticle.aspx?id=66094. Accessed May 4, 2017.

Gertler, Jeremiah. *F-35 Alternate Engine Program: Background and Issues for Congress*. (Washington, DC: Library of Congress, Congressional Research Service, 2012): 4. http://www.fas.org/sgp/crs/weapons/R41131.pdf. Accessed April 30, 2017.

———. *F-35 Joint Strike Fighter (JSF) Program*. (Washington, DC: Library of Congress, Congressional Research Service, 2014). https://digital.library.unt.edu/ark:/67531/metadc944760/?q=jeremiah%20gertler. Accessed April 27, 2017.

Granger, Congresswoman Kay. "Granger/Dicks Announce Joint Strike Fighter Caucus." (Washington, DC: Rep. Kay Granger, November 9, 2011): 1–2. https://kaygranger.house.gov/press-release/granger-dicks-announce-congressional-joint-strike-fighter-caucus. Accessed June 1, 2018.

Haffa, Robert P. "Defense Decisions for the Trump Administration." *Strategic Studies Quarterly*, 11 (1) (Spring 2017): 25–48. http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-11_Issue-1/Haffa.pdf. Accessed December 20, 2017.

Hammond, Susan Webb. "Congressional Caucuses and Party Leaders in the House of Representatives." *Political Science Quarterly*, 106 (Summer 1991): 277–294.

Hartung, William D. *Prophets of War: Lockheed Martin and the Making of the Military Industrial Complex* (New York: Nation Books, 2010).

———. *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft* (Washington, DC: Center for International Policy, 2014): 10–18. http://www.ciponline.org/images/uploads/publications/Hartung_IPR_0114_F-35_Promising_the_Sky_Updated.pdf. Accessed June 1, 2018.

Hayward, Doug. *F-35 Weapon System Overview* (Fort Worth: Lockheed Martin, 2010). http://docplayer.net/25354666-F-35-weapon-system-overview.html. Accessed June 4, 2018.

International Military Aerospace Collaboration: Case Studies in Domestic and Intergovernmental Politics. Edited by Pia Christina Wood and Davis S. Sorenson (Aldershot, UK: Ashgate, 2000).

Kastner, Scott L., and Douglas B. Grob. "Legislative Foundations of U.S.-Taiwan Relations: A New Look at the Congressional Taiwan Caucus." *Foreign Policy Analysis*, 5 (1) (January 2009): 57–72. https://doi.org/10.1111/j.1743-8594.2008.00083.x.

Koistinen, Paul A.C. *State of War: The Political Economy of American Warfare, 1945–2011* (Lawrence: University Press of Kansas, 2011).

Lassman, Thomas C. *Sources of Weapons System Innovation in the Department of Defense: The Role of In-House Research and Development, 1945–2000* (Washington, DC: United States Army Center of Military History, 2011). http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_51-2-1.pdf. Accessed April 27, 2017.

"Lightning Rod: F-35 Fighter Family Capabilities and Controversies." *Defense Industry Daily* (July 24, 2015): 3. https://www.defenseindustrydaily.com/lightning-rod-f-35-fighter-family-capabilities-and-controversies-021922/. Accessed April 27, 2017.

Linster, Bruce G., Stephen Slate, and Robert L. Waller. "Consolidation of the U.S. Defense Industrial Base: Impact on Research Expenditures." *Acquisition Review Quarterly*, 9 (2) (Spring 2002): 143–149. http://webharvest.gov/peth04/20041019074635/http://www.dau.mil/pubs/arq/2002arq/SlateSP2.pdf. Accessed May 6, 2017.

Lockheed Martin. "F-35 Lightning II: Domestic Impact." https://www.f35.com/about/economic-impact-map. Accessed June 1, 2018.

———. *History: F-35 Program Timeline*. (Fort Worth: Lockheed Martin, 2015): 1. https://www.f35.com/about/history/. Accessed April 29, 2017.

———. "Development of F-35 3i Software for USAF IOC Complete." (May 9, 2016a): 1–2. https://www.f35.com/news/detail/development-of-f-35-3i-software-for-usaf-ioc-complete. Accessed June 1, 2018.

———. "F-35 Helmet, Ahead of Our Time." (November 19, 2016b): 4–6. https://www.f35.com/news/detail/f-35-helmet-ahead-of-our-time. Accessed February 13, 2017.

———. "F-35C Back at Sea for Third Round of Carrier Tests." (August 16, 2016c): 1–2. https://www.f35.com/news/detail/f-35c-back-at-sea-for-3rd-round-of-carrier-tests. Accessed February 13, 2017.

———. "Agreement Reached on Lowest Priced F-35s in Program History." (February 3, 2017): 4–7. https://www.f35.com/news/detail/agreement-reached-on-lowest-priced-f-35s-in-program-history. Accessed February 13, 2017.

Lorell, Mark A., Michael Kennedy, et al. Do Joint Fighter Programs Save Money? (Santa Monica: Rand Corporation, 2013): xii–xiv. http://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1225/RAND_MG1225.pdf. Accessed May 6, 2017.

"Marine Corps F-35B Conducts Combat Strikes in Afghanistan." (Washington, DC: Department of Defense, 2018, September 28): 1–2. https://dod.defense.gov/News/Article/1647694/marine-corps-f-35b-conducts-combat-strikes-in-afghanistan/. Accessed October 10, 2018.

Miller, Kristina C. "The Constituency Motivations of Caucus Membership." *American Politics Research*, 39 (5) (September 2011): 885–920. https://doi.org/10.1177/1532673X11407148.

National Defense Authorization Act for Fiscal Year 1996: Conference Report to Accompany S. 1124. House Report 104–450. (Washington, DC: GPO, 1996): 706.

National Defense Authorization Act for Fiscal Year 2018. (Senate Report 115-125). (Washington, DC: GPO, 2017): 116–117. http://purl.fdlp.gov/GPO/gpo82611. Accessed December 20, 2017.

Pietrucha, Michael W. "The Comanche and the Albatross About Our Neck was Hung." *Air and Space Power Journal*, 28 (3) (May–June 2014): 136. http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-3/F-Pietrucha.pdf. Accessed May 11, 2017.

Poole, Walter S. *Acquisition History Volume II: Adapting to Flexible Response, 1960–1968* (Washington, DC: Historical Office of the Secretary of Defense, 2014). http://history.defense.gov/Portals/70/Documents/acquisition_pub/OSDHO-Acquisition-Series-Vol-2.pdf. Accessed April 27, 2017.

President of the United States. *National Security Strategy of the United States of America* (Washington, DC: The White House, 2017). https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905-2.pdf. Accessed December 20, 2017.

Przystrup, James Z., and Phillip C. Saunders. *Asia and the Trump Administration: Challenges, Opportunities and a Road Ahead* (Washington, DC: National Defense University Press, 2017). http://ndupress.ndu.edu/Media/News/Article/1271523/asia-and-the-trump-administration-challenges-opportunities-and-a-road-ahead/. Accessed December 20, 2017.

Public Law 94-106. "Department of Defense Appropriations Authorization Act, 1976." 89 *U.S. Statutes at Large* 539.

Public Law 97-86. "Department of Defense Authorization Act, 1982." 95 *U.S. Statutes at Large* 1129–1132.

Public Law 97-252. "Department of Defense Authorization Act, 1983." *96 U.S. Statutes at Large* 741–746.

Public Law 101-510. "National Defense Authorization Act for Fiscal Year 1991." 104 *U.S. Statutes at Large* 1638–1667.

Public Law 108-136. "National Defense Authorization Act for Fiscal Year 2004." 117 *U.S. Statutes at Large* 1540–1541.

Public Law 109-163. "National Defense Authorization Act for Fiscal Year 2006." 119 *U.S. Statutes at Large* 3367–3370.

Public Law 111-23. "Weapons System Acquisition Reform Act of 2009." 123 *U.S. Statutes at Large* 1704–1733.

Public Law 111-84. "National Defense Authorization Act for Fiscal Year 2010." 123 *U.S. Statutes at Large*, 2238–2239, 2734, 2767, 2772.

Public Law 112-25. "Budget Control Act of 2011." 125 *U.S. Statutes at Large* 240–267.

Public Law 112-81. "National Defense Authorization Act for Fiscal Year 2012." 125 *U.S. Statutes at Large* 1325.

Public Law 112-239. "National Defense Authorization Act for Fiscal Year 2013." 126 *U.S. Statutes at Large* 2237, 2261.

Public Law 113-66. "National Defense Authorization Act for Fiscal Year 2014." 127 *U.S. Statutes at Large* 1093, 1115.

Public Law 113-201. "Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015." 128 *U.S. Statutes at Large* 3915, 3939.

Sales, Leigh. "Joel Fitzgibbon Joins Lateline." (Sydney: Australian Broadcasting Corporation, September 24, 2008): 1–5. http://www.abc.net.au/lateline/joel-fitzgibbon-joins-lateline/521598. Accessed December 21, 2017.

Schroeder, Wayne A. "The Future U.S. Defense Budget." *Orbis*, 61 (1) (Winter 2017): 64–75. https://doi.org/10.1016/j.orbis.2016.12.003.

"Statement of Admiral William E. Gortney, United States Navy Commander United States Northern Command and North American Aerospace Defense Command Before the Senate Armed Services Committee." (Washington, DC: Senate Armed Services Committee, 2015): 5. http://www.armed-services.senate.gov/imo/media/doc/Gortney_03-12-15.pdf. Accessed May 5, 2017.

"Statement Regarding Media Coverage of F-35 Joint Strike Fighter." (Santa Monica: Rand Corporation, September 25, 2008): 1. http://www.rand.org/news/press/2008/09/25.html. Accessed May 1, 2017.

Sullivan, Michael J. *F-35 Joint Strike Fighter: Preliminary Observations on Program Progress* (Washington, DC: GAO, 2016): 4. http://www.gao.gov/assets/680/676012.pdf. Accessed February 13, 2017.

Trump, Donald F. "The F-35 Program and Cost is Out of Control." (December 12, 2016). https://twitter.com/realDonaldTrump/status/808301935728230404. Accessed February 13, 2017.

U.S. Air Force. "General Janet C. Wolfenbarger." (Washington, DC: U.S. Air Force 2015): 1–2. http://www.af.mil/AboutUs/Biographies/Display/tabid/225/Article/107934/general-janet-c-wolfenbarger.aspx. Accessed June 1, 2018.

U.S. Congress. Senate Committee on Appropriations. *Department of Defense Appropriations for Fiscal Year 1999* (Washington, DC: GPO, 1998): 47, 55.

———. Senate Committee on Appropriations. *Department of Defense Appropriations for Fiscal Year 2000.* (Washington, DC: GPO, 1999).

———. House Committee on Government Reform. Subcommittee on National Security, Veterans Affairs, and International Relations. *F-22 Cost Controls* (Washington, DC: GPO, 2000a): 99. http://purl.access.gpo.gov/GPO/LPS7076. Accessed April 28, 2017.

———. House Committee on Government Reform. Subcommittee on National Security, Veterans Affairs, and International Relations. *Joint Strike Fighter Acquisition Reform: Will If Fly?* (Washington, DC: GPO, 2000b): 5–9. http://purl.access.gpo.gov/GPO/LPS13019. Accessed April 28, 2017.

———. House Committee on Small Business. *Pentagon's Procurement Policies With Respect to Small Business* (Washington, DC: GPO, 2002a): 18. http://purl.access.gpo.gov/GPO/LPS15167. Accessed April 29, 2017.

———. Senate Committee on Armed Services. *Department of Defense's Quadrennial Defense Review (QDR)* (Washington, DC: GPO, 2002b): 117–118. http://purl.fdlp.gov/GPO/gpo46358. Accessed April 29, 2017.

———. Senate Committee on Armed Services. *Future of the North Atlantic Treaty Organization (NATO)* (Washington, DC: GPO, 2002c).

———. House Committee on Government Reform, Subcommittee on National Security, Emerging Threats, and International Relations. *Controlling Costs in Tactical Aircraft Programs* (Washington, DC: GPO, 2003): 181. http://purl.access.gpo.gov/GPO/LPS40567. Accessed April 29, 2017.

———. House Committee on Government Reform, Subcommittee on National Security, Emerging Threats, and International Relations. *Is DOD Meeting Joint Strike Fighter [JSF] International Cooperative Program Goals* (Washington, DC: GPO, 2004a): 1.

———. Senate Committee on Appropriations. Subcommittee on Defense. *Department of Defense Appropriations For Fiscal Year, 2005* (Washington, DC: GPO, 2004b): 212. http://purl.access.gpo.gov/GPO?LPS58231. Accessed April 30, 2017.

———. House Committee on the Budget. *National and Homeland Security: Meeting Our Needs* (Washington, DC: GPO, 2005a): 35–36. http://purl.access.gpo.gov/GPO/LPS60598. Accessed April 30, 2017.

———. Senate Committee on Armed Services. *Department of Defense Authorizations for Fiscal Year 2005: Part 1* (Washington, DC: GPO, 2005b): 63–64. http://www.gpo.gov/fdsys/pkg/CHRG-108shrg93571/pdf/CHRG-108shrg93571.pdf. Accessed April 29, 2017.

———. House Committee on Armed Services. *Issues Relating to Defense Acquisition Reform* (Washington, DC: GPO, 2007): 16. http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg32970/pdf/CHRG-109hhrg32970.pdf. Accessed April 30, 2017.

———. Senate Committee on Armed Services. *Acquisition of Major Weapons Systems by the Department of Defense and S. 454, the Weapons System Acquisitions Reform Act of 2009* (Washington, DC: GPO, 2009a). http://purl.access.gpo.gov/GPO/LPS117925. Accessed May 4, 2017.

———. House Committee on Appropriations. Subcommittee on Defense. *Department of Defense Appropriations for 2009.* (Washington, DC: GPO, 2009b): 266–267. http://purl.access.gpo.gov/GPO/LPS110514. Accessed May 1, 2017.

———. House Committee on Armed Services. Subcommittees on Air and Land Forces and Seapower and Expeditionary Forces. *Hearing on National Defense Authorization Act for Fiscal Year 2008 and Oversight of Previously Authorized Programs: Budget Request on Department of Defense Aircraft Programs* (Washington, DC: GPO, 2009c): 184. http://purl.access.gpo.gov/GPO/FDLP133. Accessed April 29, 2017.

———. House Committee on Armed Services. *Hearing on National Defense Authorization Act for Fiscal Year 2009 and Oversight of Previously Authorized Programs: Budget Request From the Department of the Navy* (Washington, DC: GPO, 2009d): 42. http://purl.access.gpo.gov/GPO/FDLP145. Accessed May 1, 2017.

———. House Committee on Natural Resources. Subcommittee on Energy and Mineral Resources. *Strategic and Critical Minerals Policy: Domestic Minerals Supplies and Demands in a Time of Foreign Supply Disruptions* (Washington, DC: GPO, 2011): 33–36. http://purl.fdlp.gov/GPO/gpo15613. Accessed May 4, 2017.

———. House Committee on Homeland Security. Subcommittee on Oversight, Investigations, and Management. *America is Under Cyber Attack: Why Urgent Action is Needed* (Washington, DC: GPO, 2013a): 15. http://purl.fdlp.gov/GPO/gpo34535. Accessed May 11, 2017.

———. Senate Committee on Appropriations. Subcommittee on Defense. *Department of Defense Appropriations for Fiscal Year 2014* (Washington, DC: GPO, 2013b): 10. http://www.gpo.gov/fdsys/pkg/CHRG-113shrg39104549/pdf/CHRG-113shrg39104549.pdf. Accessed May 4, 2017.

———. Senate Committee on Armed Services. *Department of Defense Authorization for Appropriations for Fiscal Year 2013 and the Future Years Defense Program* (Washington, DC: GPO, 2013c): 259. http://purl.fdlp.gov/GPO/gpo34177. Accessed May 4, 2017.

———. House Committee on Armed Services. *Hearing on National Defense Authorization Act for Fiscal Year 2014 and Oversight of Previously Authorized Programs: Budget Request from the Department of Defense* (Washington, DC: GPO, 2013d): 7. http://purl.fdlp.gov/GPO/gpo41321. Accessed May 4, 2017.

———. House Committee on Armed Services. *Initial Conclusions Formed by the Defense Strategic Choices and Management Review* (Washington, DC: GPO, 2013e): 99. http://purl.fdlp.gov/GPO/gpo42204. Accessed May 4, 2017.

———. Senate Committee on Armed Services. Subcommittee on Airland. *Department of Defense Authorization for Appropriations for Fiscal Year 2014 and the Future Years Defense Program: Part 4 Airland* (Washington, DC: GPO, 2014a): 10–11. http://purl.fdlp.gov/GPO/gpo46909. Accessed May 4, 2017.

———. House Committee on Energy and Commerce. Subcommittee on Oversight and Investigations. *Cyber Espionage and the Theft of U.S. Intellectual Property and Technology* (Washington, DC: GPO, 2014b): 23. http://purl.fdlp.gov/GPO/gpo47093. Accessed May 11, 2017.

———. House Committee on Armed Services. Subcommittee on Tactical Air and Land Forces. *National Defense Authorization Act for Fiscal Year 2015 and Oversight of Previously Authorized Programs: Fiscal Year 2015 Navy, Marine Corps, and Air Force Combat Aviation Programs* (Washington, DC: GPO, 2014c): 1–5. http://www.gpo.gov/fdsys/pkg/CHRG-113hhrg87858/pdf/CHRG-113hhrg87858.pdf. Accessed May 5, 2017.

———. Senate Committee on Appropriations. Subcommittee on Defense. *Department of Defense Appropriations for Fiscal Year 2015* (Washington, DC: GPO, 2015a): 60. http://www.gpo.gov/fdsys/pkg/CHRG-113shrg49104595/pdf/CHRG-113shrg49104595.pdf. Accessed May 5, 2017.

———. Senate Committee on Armed Services. *Department of Defense Authorization for Appropriations for Fiscal Year 2016 and the Future Years Defense Program: Part 2: Seapower* (Washington, DC: GPO, 2015b): 123. http://purl.fdlp.gov/GPO/gpo67057. Accessed June 4, 2018.

———. House Committee on Appropriations. Subcommittee on Defense. *Department of Defense Appropriations for* 2015, *Part 1* (Washington, DC: GPO, 2015c): 1:45, 185. http://purl.fdlp.gov/GPO/gpo54960. Accessed May 5, 2017.

———. House Committee on Armed Services. *Statement of the Hon. Sean J. Stackley Assistant Secretary of the Navy (Research, Development, and Acquisition) and Lt. General Christopher Bogdan, Program Executive Officer F-35* (Washington, DC: Senate Armed Services Committee, March 5, 2015d): 2–5. http://docs.house.gov/meetings/AS/AS25/20150414/103032/HHRG-114-AS25-Wstate-BogdanC-20150414.pdf. Accessed May 5, 2017.

———. House Committee on Armed Services. *Update on the F-35 Joint Strike Fighter Program* (Washington, DC: GPO, 2016a): 3. http://purl.fdlp.gov/GPO/gpo68712. Accessed February 13, 2017.

———. Senate Committee on Appropriations. *Department of Defense Appropriations Bill, 2017*. Senate Report 114-263 (Washington, DC: GPO, May 26, 2016b): 8–9. https://www.govinfo.gov/content/pkg/CRPT-114sprt263/pdf/CRPT-114srpt263.pdf. Accessed February 8, 2017.

———. House Committee on Armed Services. *Aviation Readiness: What's The Flight Plan* (Washington, DC: House Armed Services Committee, 2017a): 6. https://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Bio-RudderS-20171109.pdf. Accessed June 1, 2018.

———. House Committee on Armed Services. *Military Aviation Readiness and Safety Hearing* (Washington, DC: House Armed Services Committee, November 9, 2017b). https://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Wstate-NowlandC-20171109.pdf. Accessed June 1, 2018.

———. House Committee on Armed Services. Subcommittee on Tactical Air and Land Forces. *Military Services Fifth Generation Tactical Aircraft Challenges and F-35 Joint Strike Fighter Program Update* (Washington, DC: GPO, 2017c): 44–47. http://purl.fdlp.gov/GPO/gpo85874. Accessed December 21, 2017.

———. Senate Committee on Armed Services. "John S. McCain National Defense Authorization Act for Fiscal Year 2019." (Washington, DC: Senate Committee on Armed Services, May 24, 2018): 1, 8–9. https:/www.armed-services.senate.gov/download/fy19-ndaa-summary. Accessed June 4, 2018.

U.S. Congressional Budget Office. *CBO Testimony: Statement of Christopher Jehn on Modernizing Tactical Aircraft Before the Subcommittee on Airland, Senate Armed Services Committee*. (Washington, DC: CBO, March 10, 1999): 3–4. https://www.cbo.gov/sites/default/files/106th-congress-1999-2000/reports/031099.pdf. Accessed April 28, 2017.

———. *Budget Options* (Washington, DC: CBO, 2000): 79. https://www.cbo.gov/sites/default/files/106th-congress-1999-2000/reports/wholereport_0.pdf. Accessed April 28, 2017.

———. *Alternatives for Modernizing U.S. Fighter Forces* (Washington, DC: CBO, 2009): 25–44, esp. 28–29. http://purl.access.gpo.gov/GPO/LPS116409. Accessed May 5, 2017.

U.S. Department of Defense. *Report on the Bottom-Up Review*. (Washington, DC: DOD, 1993): 35–38. http://babel.hathitrust.org/cgi/pt?id=uc1.32106010456157;view=1up;seq=48. Accessed April 28, 2017.

———. *Briefing on the Joint Strike Fighter Contract Announcement* (Washington, DC: DOD, October 26, 2001a): 1–5. http://www.defense.gov/utility/printitem.aspx?print=http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=2186. Accessed April 29, 2017.

———. *Contracts: No. 544-01*. (Washington, DC: DOD, October 26, 2001b): 1. http://www.defense.gov/Contracts/Contract.aspx?ContractID=2131. Accessed April 29, 2017.

———. Office of Inspector General. *Export Controls: Controls Over the Export of Joint Strike Fighter Technology* (Washington, DC: DODIG, 2006): 8–9. https://media.defense.gov/2006/Jan/11/2001712075/-1/-1/1/D-2006-044.pdf. Accessed August 14, 2018.

———. "DOD News Briefing With Secretary Gates and Admiral Mullen from the Pentagon." (Washington, DC: DOD, January 6, 2011): 3. http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4747. Accessed May 4, 2017.

———. "Panetta Lifts F-35 Fighter Variant Probation." (Washington, DC: DOD, January 20, 2012): 1. http://archive.defense.gov/news/newsarticle.aspx?id=66879. Accessed May 4, 2017.

———. *Quality Assurance Assessment of the F-35 Lightning II Program* (Washington, DC: DODIG, 2013): i. https://media.defense.gov/2013/Sep/30/2001713313/-1/-1/1/DODIG-2013-140.pdf. Accessed May 14, 2018.

———. *F-35 Lightning II Program Quality Assurance and Corrective Action Evaluation* (Washington, DC: DODIG, 2015a): i. https://media.defense.gov/2015/Mar/11/2001713476/-1/-1/1/DODIG-2015-092.pdf. Accessed August 14, 2018.

———. Office of the Undersecretary of Defense Acquisitions, Technology, and Logistics. *Selected Acquisition Report (SAR): Summary Tables as of December 31, 2014*. (Washington, DC: DOD, 2015b): 6. https://www.acq.osd.mil/ara/sar/SST-2014-12.pdf. Accessed May 6, 2017.

———. Office of the Undersecretary of Defense (Comptroller) CFO. *Program Acquisition Cost by Weapons System: Fiscal Year 2016 Budget Request* (Washington, DC: DOD, 2015c): 1–6. http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2016/FY2016_Weapons.pdf. Accessed May 4, 2017.

———. Director of Operational Test and Evaluation. *FY 2016 Annual Report* (Washington, DC: DOD, 2017a): 47. http://www.dote.osd.mil/pub/reports/FY2016/pdf/other/2016DOTEAnnualReport.pdf. Accessed February 16, 2017.

———. Manufacturing and Industrial Base Policy. *Annual Industrial Capabilities Report to Congress* (Washington, DC: DOD, 2017b). http://www.businessdefense.gov/Portals/51/Documents/Resources/2017 AIC RTC 05-17-2018 - Public Release.pdf?ver=2018-05-17-224631-340. Accessed June 1, 2018.

———. *Nuclear Posture Review* (Washington, DC: DOD, 2018a). https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF. Accessed June 1, 2018.

———. *Summary of the 2018 National Defense Strategy* (Washington, DC: DOD, 2018b). https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf. Accessed June 1, 2018.

U.S. General Accounting Office. *Combat Air Power: Joint Assessment of Air Superiority Can Be Improved* (Washington, DC: GAO, 1997): 7–8. http://www.gao.gov/assets/160/155769.pdf. Accessed April 28, 2017.

———. *Joint Strike Fighter Acquisition: Developmental Schedule Could Be Changed to Reduce Risks* (Washington, DC: GAO, 2000): 2–3. http://www.gao.gov/assets/110/108316.pdf. Accessed April 28, 2017.

———. *Joint Strike Fighter Acquisition: Cooperative Program Needs Greater Oversight to Ensure Goals are Met* (Washington, DC: GAO, 2003). http://www.gao.gov/new.items/d03775.pdf. Accessed April 20, 2017.

U.S. Government Accountability Office. *Defense Acquisitions: Assessments of Selected Major Weapons Programs* (Washington, DC: GAO, 2005a): 79. www.gao.gov/assets/250/245884.pdf. Accessed April 30, 2017.

———. *Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy* (Washington, DC: GAO, 2005b): 2–4. http://www.gao.gov/new.items/d05271.pdf. Accessed April 30, 2017.

———. *Joint Strike Fighter: DOD Plans to Enter Production Before Testing Demonstrates Acceptable Performance* (Washington, DC: GAO, 2006): 2–4. www.gao.gov/assets/250/249301.pdf. Accessed April 30, 2017.

———. *Defense Acquisitions: Analysis of Costs for the Joint Strike Fighter Engine Program: Statement of Michael Sullivan* (Washington, DC: GAO, March 22, 2007a): 1–2. www.gao.gov/assets/120/116016.pdf. Accessed April 30, 2017.

———. *Joint Strike Fighter: Progress Made and Challenges Remain* (Washington, DC: GAO, 2007b): 2–3. www.gao.gov/assets/260/257628.pdf. Accessed April 30, 2017.

———. *Defense Acquisitions: Significant Challenges Ahead in Developing and Demonstrating Future Combat System's Network and Software* (Washington, DC: GAO, 2008a): 17. www.gao.gov/assets/280/273386.pdf. Accessed May 1, 2017.

———. *Joint Strike Fighter: Recent Decisions by DOD Add to Program Risk* (Washington, DC: GAO, 2008b): 2–3. www.gao.gov/assets/280/273563.pdf. Accessed May 1, 2017.

———. *Weapons Acquisition Reform: Reform Act is Helping DOD Acquisition Programs Reduce Risk, but Implementation Challenges Remain* (Washington, DC: GAO, 2012): 14–29. http://www.gao.gov/assets/660/650908.pdf. Accessed May 4, 2017.

———. F-*35 Joint Strike Fighter: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities* (Washington, DC: GAO, 2013a): 1–3, 5–9, 23. http://www.gao.gov/assets/670/661842.pdf. Accessed May 5, 2017.

———. *F-35 Joint Strike Fighter Program: Restructuring Has Improved the Program, but Affordability Challenges and Other Risks Remain* (Washington, DC: GAO, 2013b): 2–5. http://www.gao.gov/assets/660/655295.pdf. Accessed May 5, 2017.

———. *Sequestration: Observations on the Department of Defense's Approach in Fiscal Year 2013* (Washington, DC: GAO, November 7, 2013c): 37. http://www.gao.gov/assets/660/655295.pdf. Accessed May 5, 2017.

———. *F-35 Joint Strike Fighter: Observations on Program Progress* (Washington, DC: GAO, April 14, 2015): 1–6. http://www.gao.gov/assets/670/669605.pdf. Accessed May 5, 2017.

———. *Weapons Systems Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success* (Washington, DC: GAO, 2016): 21–22. http://www.gao.gov/assets/690/681106.pdf. Accessed February 14, 2017.

———. *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency* (Washington, DC: GAO, 2017): 12–20. https://www.gao.gov/assets/690/687982.pdf. Accessed December 20, 2017.

U.S. National Commission on Fiscal Responsibility and Reform. "200 Billion in Illustrative Savings." (Washington, DC: The Commission, November 12, 2010): 18–19. http://www.fiscalcommission.gov/sites/fiscalcommission.gov/files/documents/Illustrative_List_11.10.2010.pdf. Accessed May 4, 2017.

U.S. Office of the Undersecretary of Defense For Acquisition & Technology. *Report of the Defense Science Board Task Force on the Joint Advanced Strike Technology (JAST) Program* (Washington, DC: Defense Science Board, 1994): ES-2. http://www.dtic.mil/dtic/tr/fulltext/u2/a292094.pdf. Accessed April 28, 2017.

"USS Lincoln Test F-35C Lightning II at Sea." (Washington, DC: JSF Joint Program Office, September 11, 2017): 1–2. http://www.jsf.mil/news/docs/20170912_USS_Lincoln_Tests_F-35C_Lightning_II_at_Sea.pdf. Accessed December 20, 2017.

"Vice Admiral Mathias W. Winter Director, Joint Strike Fighter Program, Office of the Secretary of Defense." (Washington, DC: U.S. Navy, June 9, 2017): 1–2. http://www.navy.mil/navydata/bios/navybio.asp?bioID=578. Accessed December 20, 2017.

CHAPTER 5

JSF and Australia

Australia is one of the United States' closest allies, having conducted combat operations supporting US forces in many post-World War II conflicts. It also cooperates closely with the US military as its military forces seek to achieve optimum interoperability with the US military. This cooperation between Canberra and Washington has generally been in place for nearly six decades since the 1955 Australia New Zealand United States (ANZUS) agreement and involved participation by the governments representing the conservative Liberal-National Party (LIB) coalition and the Australian Labour Party (ALP).

Governments from both of these parties have sought to maintain Canberra's close security ties with the United States while also balancing these ties with increasingly important economic and trade relationships with other Asia-Pacific countries. Australia is a major participant in the JSF program, but also shares concerns about this program's rising costs and production delays with the United States and other countries. Such concerns are reflected in Australian political and policymaking debate.[1]

Australian Involvement with JSF

Australian participation in the JSF began in the 1990s as part of project AIR 6000-New Air Combat Capability (NACC) which initially appeared in the *Defence New Major Capital Equipment Proposals 1998–2003*.[2] This document advocated developing new capabilities to replace the Royal

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_5

Australian Air Force's (RAAF) F/A-18A/B fighter aircraft at the end of its anticipated lifespan between 2012 and 2015 and the F-111 strike/reconnaissance plane expected to reach terminal status in 2020. Phase 1 of AIR 6000 was to be a Capability Definition Study to consider options for a single aircraft type to replace both of these aircraft and have other strike capability options.[3]

The 2000 Defence White Paper issued by Prime Minister John Howard's (LIB—Bennelong, NSW) Coalition Government stressed the need to have an air combat capability to support a regional coalition and provide air defense support for ground and maritime deployed forces in the region. This document also mentioned that the Australian Defence Force (ADF) needed to acquire up to 100 new combat aircraft to replace the F-18 and F-111 to enter service in 2012.[4]

November 2001 saw the AIR 6000 program office issue a Market Survey to ensure the widest possible mix of force options would be considered for a future Australian fighter aircraft program. The following month saw the Department of Defence (Defence) issue a Request for Information on nine potential air combat options. The year 2002 saw the opportunity for Australia to enter the JSF program and Defence submitted a case for approval to the Australian Government's Cabinet-level National Security Committee which authorized Defence to negotiate Australian entry into the JSF partnership with the United States. These negotiations were successfully concluded in October 2002. The result of these negotiations was Australia agreeing to spend up to $A 150 million over the next ten years to join JSF as a level three partner which requires contributing 1–2% of engineering, manufacturing, and development costs. While not a formal decision to acquire the JSF, it was a decision to participate in the development and expected acquisition of this aircraft and an opportunity for Australian companies to bid for JSF development work. This time period also saw Australia and the United States agree to review their military interoperability.[5]

Additional factors influencing Australia's decision to purchase the JSF include the F-35 being the only fifth-generation fighter which could reasonably fit Canberra's security needs, the refusal of the US Congress to release for sale the F-22 Raptor, primarily an air superiority fighter believed to have insufficient ground strike capabilities, and the F-35 being the only choice if Australia wanted to retain technological air superiority over its immediate Asian neighbors who were expected to receive the newest versions of Russian Sukhoi SU-27/30 aircraft beginning in 2010.[6]

On November 10, 2006, Australian Defence Minister Brendan Nelson (LIB—Bradfield, NSW) announced that JSF had been given First Pass approval by the Government, that a MOU with the United States would be signed in the following month, and that 20 Australian companies had already won work on this contract worth an estimated $A 90 billion.[7] Signing the MOU with the United States in Washington on December 12, 2006, Nelson commented: "This is an extremely important day for Australia and our air defence capability. The Joint Strike Fighter is most certainly the correct aircraft for Australia in terms of air-to-combat and its strike capabilities. It will see Australia through the next 30–40 years. It is a state-of-the-aircraft and we look forward very much to the imminent first flight."[8]

Concerns over possible JSF delays and cost increases were already prevalent in Australian parliamentary debates. On December 4, 2006, Representative Robert McClellan (ALP—Barton, NSW) asked Nelson if the government had considered whether JSF project delays could result in aircraft delivery delays; whether the Government has made plans to acquire other aircraft if such delays occur; and whether the Government has considered acquiring the F-22 or F-18 and made the necessary analysis to determine which aircraft to purchase if the need arises. Replying on February 28, 2007, Nelson announced that the JSF remained on target to deliver aircraft and that cost-effective options had been developed if there were JSF production and delivery delays.[9]

The Australians, however, were also concerned with the chance of a capability gap if the F-111 was retired in 2010 and decided to acquire 24 F/A-18F Super Hornet multirole aircraft for $A 6 billion on March 6, 2007, to hedge against possible JSF production delays while announcing that Canberra planned to acquire its first JSF in 2013.[10]

On February 18, 2008, the recently elected Labour Party Government of Prime Minister Kevin Rudd (Griffith, QLD) announced it would conduct an air combat capability review. This review's purpose was examining Australian air combat needs out to 2045 and included considering the relative capabilities of current and projected fourth and fifth-generation fighters such as the JSF and the case for or against acquiring the F-22.[11] Increasing JSF costs concerns were also documented in a May 2008 report by the government-funded Australian Strategic Policy Institute which announced that JSF's real cost has increased by at least 30% since the 2002 decision to join the program, that if JSF cost growth is consistent with historical trends overall costs will be 50% above the initial estimate which the then-current budget would enable 90 or more JSFs to be purchased, and that cost pressures can be eased by buying some aircraft later than currently planned to exploit expected cost reductions in JSF's first years of production. This assessment observed that purchasing the JSF would cost $A 12.3 billion which would be financially attainable though further cost increases would reduce the number of aircraft which could be acquired.[12]

On September 24, 2008, Representative Shayne Neumann (ALP—Blair, QLD) asked Rudd's Defence Minister Joel Fitzgibbon (ALP—Hunter, NSW) about the JSF's procurement and the importance of the government carefully considering this acquisition and "getting it right." Fitzgibbon responded by acknowledging the presence of an important airbase in Neumann's district and said that the government would not be pressured into making a decision while criticizing what he saw as the Howard Government's failure to comparatively analyze competing aircraft alternatives. He went on to stress that the F-22 was the only fifth-generation aircraft in service internationally while acknowledging that the JSF might emerge on the market in coming years and that the government was concerned with giving the RAAF the capability it needs to protect national security while also giving taxpayers value for money.[13]

In its May 2009 Defense White Paper, *Defending Australia in the Asia Pacific Century: Force 2030*, Rudd's government stated Australia would acquire 100 JSFs along with supporting systems and weapons. Three operational squadrons of at least 72 aircraft would be acquired initially, with remaining aircraft acquired in conjunction with the F/A-18 Super Hornets to ensure there are no gaps in Australian air combat capability.[14]

On November 25, 2009, Defence Minister Senator John Faulkner (ALP—NSW) announced Australia would purchase 14 CTOL JSFs for $A 3.2 billion.[15] Faulkner's release showed the government's intent to decide about the next (and much larger) aircraft order in 2012. However, the 2011 release of the Defence Capability Plan showed the first JSF squadron's Initial Operating Capability had slipped from 2015 to 2018.[16]

Prime Minister Julia Gillard (ALP—Lalor, VIC) and Defence Minister Stephen Smith (ALP—Perth, WA) in a May 3, 2012, joint press conference announced that Australia would delay purchasing a second consignment of 12 JSFs in an effort to save $2 billion in response to reports of $3–$6 billion in JSF cost overruns.[17]

A vivid example of the tension produced by rising JSF costs and uncertainty over aircraft quality is reflected in the following exchange in a March 16, 2012, hearing by the Parliamentary Joint Committee on Foreign

Affairs, Defence, and Trade covering highly negative evaluations of JSF from the organizations Air Power Australia and RepSim. Key participants in this exchange included Representative Dennis Jensen (LIB—Tangney, WA) who has been a persistent JSF critic and Vice Marshal Kym Osley, the Program Manager, New Aircraft Capability of the Department of Defence.

Jensen:	However, when you look at the record. … Defence ain't looking to good. APA has been far more accurate than Defence, both in terms of cost and schedule. Have you done simulations against the Su-35 with different varieties of mixed vessel loadouts against the F35?
Air Vice Marshal Osley:	Regrettably, I cannot go into the detail of exactly the types of threats we had—they were … high-end threats—and exactly how we structured that. I will see what we can share at the unclassified level.
Jensen:	I would not have thought what simulation software and what threats were analysed would have been a problem. Details of your knowledge of those threats clearly would be classified, but I do not think "Hey, we did a run against a Su-35 would have been a problem."
Osley:	The short answer is that the fighting unit for a 35 is four aircraft or more. The simulations will cover multiaircraft versus multithreats. So all that you have mentioned would be within the realms of what has been tested in our simulations.
Jensen:	I would like as much detail as you can give me on that. Have you done that using widely different engagement geometries and sensor weapon mixes—in other words, not head-to-head co-altitude? … What sort of runs have you conducted in that regard? Have you done simulations of F35s versus any aircraft that have HF over-the-horizon radar, working

with your threat group in terms of their integrated air defence system? Have you done … simulations, using adversary HF over-the-horizon radar equipped naval surface vessels as a component of IADS? Have you done … simulations using current generation passive detection systems, incorporated as additional constructive elements of an adversary against the F35 scenarios?

Osley: The simulation that has been done was actually done using highly trained fighter pilots, … using to the best of their knowledge, the best capability they could to defeat the F35 … if you use the F35 and play to its strengths, not to its weaknesses, you can prevail in air combat. Winning in air combat late in this decade and into the 2020s is not going to be easy. I am not saying that the F35 will answer all our prayers. If you use the F35 incorrectly and do not play to its strengths, you will probably lose. But the same could be said for the F18 and the F16. If we play to the F35's strengths, and it has a lot of strengths of stealth, good sensors, and exceptional situational awareness. For instance, the situational awareness is linked to the capacity of the software. It has roughly three times the software of the F22. … It has a datalink capability … exceptional for talking not only to other F35s but the rest of the system out there. If you have the right weapons on board, and they will need to be upgraded, if you have good training, good tactics and good supporting capabilities, the F35 will prevail.[18]

One analysis of Australian defense policy notes that the enduring presence of a conflict between interoperability and self-reliance in Australian defense policymaking. This assessment notes that acquiring 100 F-35s reflects Canberra's mixed motives since purchasing these is Australia's biggest step toward interoperability and all but one fighter purchased by the

RAAF since 1960 has been American. At the same time, this writer notes that even with the F-35 Australia will never be fully self-reliant in an American-led coalition participating in a major regional conflict and that Australia's role would be symbolic and strategically insignificant. He goes on to argue that Australia should concentrate on preparing itself for low- and medium-range conflicts.[19]

Australian Defence Industry Involvement

Australia's defense industry involvement in JSF production is extensive with a presence in most Australian states and territories. Examples of companies from Australia's aerospace industry and subsidiaries of multinational companies having JSF contracts up to and including 2017 and their Australian dollar contract value and activities are shown in Table 5.1.

According to a February 26, 2016, submission by the Australian Defence Department to the parliamentary Standing Committee on Foreign Affairs, Defence, and Trade, Australian industry had secured $A 554.5 million worth of JSF contracts through December 2015. The Defence Department went on to maintain that enhanced JSF production in the next four years could produce $2 billion in JSF contract opportunities for Australia by 2023 and reach a potential $4 billion by 2035.[20]

These grants are awarded through the Australian Government's New Air Combat Capability-Industry Support Program providing the following three types of assistance to eligible companies:

- Stream A: Grants of up to $A 1 million over a period no longer than 36 months for developing new or improved JSF technologies, products, processes or services, required by JSF supply chain entities capable of demonstrating more than one JSF application.
- Stream B: Grants of up to SA 250,000 over a period no longer than 18 months for developing new or improved JSF technologies, products, processes or services to enhance a company's competitiveness in winning work from JSF supply chain entities; or engaging in a study effort relating to JSF supply chain entities or the JSF Program Office.
- Stream C: Grants of up to $A 300,000 with no more than $A 100,000 per financial year for no more than 36 months to Australian universities, cooperative research centers, or publicly funded research agencies, or a company controlled by one these organizations, to undertake research assistance leading to JSF industry capability enhancements by JSF supply chain entities or the JSF program office.[21]

Table 5.1 Australian JSF contractors

Agent Oriented Software Pty. Ltd.	Melbourne, Victoria	Information broker for F-35 interoperability demonstration with network-centric infrastructure	$A 275,000
AW Bell Pty. Ltd.	Dandenong South, Victoria	Enhancing technical and manufacturing capability to support Northrop Grumman and BAE Systems component manufacture	$A 275,000
BAE Systems Australia Ltd.	Salisbury, South Australia	Northrop Grumman Information Systems Communication, Navigation and Identification, Audio Control	$A 275,000
Brenco Aerospace Pty. Ltd.	Sunshine, Victoria	Establishment of hydrogen-based high-velocity oxygen fuel aerospace capability	$A 248,570
Cablex Pty. Ltd.	East Bentleigh, Victoria	Specialized aerospace cable assemblies and harnesses	$A 164,682
CSIRO Titanium Technologies	Clayton, Victoria	Thermally assisted metal manufacturing	$A 1,053,528
Electromold Australia Pty. Ltd.	Thomastown, Victoria	Airframe and related component non-destructive testing, surface treatment, and finishing capability expansion	$A 907,977
Ferra Engineering Pty. Ltd.	Tingalpa, Queensland	Alternate Mission Equipment—weapons adaptor product process improvement	$A 275,000
George Lovitt Manufacturing Pty. Ltd. Increase competitiveness of manufacture of JSF airframe components	Montmorency, Victoria	Increase competitiveness of manufacture of JSF airframe components	$A 275,000
Heat Treatment Victoria Pty Ltd.	Campbellfield, Victoria	Aerospace and defense thermal processing	$A 9941
Levett Engineering Pty Ltd. Active interceptor housing and support parts manufacturing	Elizabeth, South Australia	Active interceptor housing and support parts manufacturing	$A 184,993

(*continued*)

Table 5.1 (continued)

Lintek Pty. Ltd.	Queanbeyan, New South Wales	Production capacity and capability increase for Radio Frequency Substrates	$A 1,049,060
Marand Precision Engineering Pty. Ltd.	Moorabbin, Victoria	Developing Australia's low-observable manufacturing capability	$A 1,100,000,000
Micreo Ltd	Eight Mile Plains, Queensland	L-Band Switched Filter design for manufacture	$A 92,825
Quickstep Operations Pty. Ltd.	Bankstown Airport, New South Wales	Rapid, low-cost curing of carbon fiber composite structures	$A 362,343
Rockwell Collins Australia Pty. Ltd.	Lane Cove West, New South Wales	Establishment of Electro-Optical Distributed Aperture System assembly manufacturing facility	$A 275,000
TAE Gas Turbines Pty. Ltd.	Amberley, Queensland	Production qualification for Harris Corporation electronics enclosures	$A 117,442

Asian Regional Security Environment

Australian acquisition of the JSF must be understood in the strategic context of steadily increasing defense spending by Southeast and Northeast Asian nations whose economic and strategic interests directly affect Australian trade and strategic interests. The Stockholm International Peace Research Institute (SIPRI) Military Expenditure Database reports East Asian nations military spending increased from $144 billion in 1998 to $318 billion in 2013. Per capita defense spending figures from these countries during this period also demonstrate significant increases, as shown in Table 5.2.

The significant economic growth experienced by many of these countries has enabled most of them to increase defense spending without having these expenditures account for additional percentages of their annual gross domestic product (GDP) as the following table demonstrates (Table 5.3).

SIPRI also provides the following documentation on annual government defense expenditures between 1998 and 2017 in constant US dollars (Table 5.4).

Further documentation of Southeast and Northeast Asia's increasing militarization concerning Australian airpower is found in SIPRI's Arms Transfers database. Between 1998 and 2016, the total value of air warfare-related weapons categories including aircraft, air defense, missiles, satellites, and sensors exported globally was as follows (Table 5.5).

Table 5.2 Asia-Pacific per capita defense spending[22]

Australia 1998 $380	2017 $1123.2
Brunei 1998 $927.7	2017 $808.7
China 1998 $14	2017 $161.9
Indonesia 1998 $4.8	2017 $31
Japan 1998 $300	2017 $356
Malaysia 1998 $51.9	2017 $110.5
Philippines 1998 $16.3	2017 $41.7
South Korea 1998 $226	2017 $768
Taiwan 1998 $421	2017 $447.3
Vietnam 2003 $10.4	2017 $53.1 estimated

Table 5.3 Asia-Pacific defense spending by GDP[23]

Australia 1998 1.9%	2017 2.0%
Brunei 1998 7.5%	2017 2.9%
China 1998 1.7%	2017 1.9%
Indonesia 1998 1.0%	2017 0.8%
Japan 1998 1.0%	2017 0.9%
Malaysia 1998 2.6%	2017 1.1%
Philippines 1998 1.7%	2017 1.4%
South Korea 1998 2.9%	2017 2.6%
Taiwan 1998 3.3%	2017 1.8%
Vietnam 2003 2.6%	2017 2.3%

Table 5.4 Asia-Pacific defense spending (US dollars)[24]

Australia 1998 $7.108 billion	2017 $26.102 billion
Brunei 1998 $294 million	2017 $348 million
China 1998 $17.528 billion	2017 $228.173 billion
Indonesia 1998 $3.231 billion	2017 $7.911 billion
Japan 1998 $37.849 billion	2017 $46.556 billion
Malaysia 1998 $1.159 billion	2017 $2.604 billion
Philippines 1998 $1.226 billion	2017 $4.508 billion
South Korea 1998 $10.458 billion	2017 $39.153 billion
Taiwan 1998 $9.232 billion	2017 $10.569 billion
Vietnam 2003 $842 million	2017 $5.074 billion

Further breakdown on the financial value of these airpower-related categories have been transferred to Southeast and Northeast Asian countries from various international suppliers between 1998 and 2017 is also provided by SIPRI (Table 5.6).

Table 5.5 Global aerospace arms transfers[25]

Aircraft	1998 $14.502 billion	Through 2017 $220.405 billion
Air Defense Systems	1998 $865 million	Through 2017 $23.300 billion
Missiles	1998 $3.912 billion	Through 2017 $62.904 billion
Satellites	1998 $50 million	Through 2017 $300 million
Sensors	1998 $1.168 billion	Through 2017 $27.133 billion

Table 5.6 Asia-Pacific aerospace defense transfers[26]

Brunei Aircraft	$94 million
Missiles	$40 million
Sensors	$38 million (Through 2017)
China Aircraft	$17.416 billion
Air Defense Systems	$2.331 billion
Missiles	$5.603 billion
Sensors	$2.356 billion (Through 2017)
Indonesia Aircraft	$2.707 billion
Air Defense Systems	$251 million
Missiles	$309 million
Sensors	$321 million (Through 2017)
Japan Aircraft	$6.479 billion
Air Defense Systems	$364 million
Missiles	$908 million
Sensors	$845 million (Through 2017)
Malaysia Aircraft	$1.602 billion
Air Defense Systems	$84 million
Missiles	$585 million
Sensors	$298 million (Through 2017)
North Korea Aircraft	$170 million
Missiles	$92 million (Through 2017)
Philippines Aircraft	$541 million
Missiles	$4 million
Sensors	$30 million (Through 2017)
South Korea Aircraft	$10.120 billion
Air Defense Systems	$1.472 billion
Missiles	$2.654 billion
Sensors	$1.001 billion (Through 2017)
Taiwan Aircraft	$6.168 billion
Air Defense Systems	$446 million
Missiles	$1.912 billion
Sensors	$496 million (Through 2017)
Vietnam Aircraft	$2.358 billion
Air Defense Systems	$379 million
Missiles	$1.109 billion
Sensors	$206 million (Through 2017)

An analysis on the role of airpower such as the JSF in Australian strategic operational planning and its benefits to Canberra's geopolitical interests is provided in the following assessment:

> The combination of its speed, reach and responsiveness provide the capability to carry out time-critical precision strikes on fleeting targets of opportunity. In the contemporary conflict scenario this is a coveted capability that could potentially reduce the total expenditure if the target that is neutralized is of sufficiently high strategic importance to the adversary. In expeditionary operations, which are becoming more common amongst the forces of the developed world, airlift capabilities are critical to success. While expenditure per unit load of warfighting material and provisions may be high in airlift as compared to surface transportation, the speed, reach and penetration capabilities of aircraft that will sustain a surface force far away from home base cannot be quantified in dollar terms. Overall, expeditionary operations are better served by airlift than being supported by surface-based lines of supplies for reasons of security and a much higher degree of assurance.[27]

Discussion

Australian opinion on the JSF is as divided as opinion in other participating countries. On April 23, 2014, Prime Minister Tony Abbott's (LIB—Warringah, NSW) conservative Coalition government approved the purchase of 58 additional JSFs at a cost of $A 12.4 billion including facilities, training, and weapons. Nearly $A 1.6 billion in new facilities will be constructed for the JSF at RAAF Base Jamestown, New South Wales, and RAAF Base Tindal in the Northern Territory. The government contended that the JSF, along with the F-18 Super Hornet and Growler electronic warfare aircraft, would enable Australia to maintain a regional combat edge. The JSF is scheduled to arrive in Australia in 2018 in anticipation of a 2020 deployment.[28]

RAAF pilots interviewed for a story in the *Australian* supported the Abbott Government's decision to purchase the JSF, with RAAF fighter pilot Geoff Brown saying the JSF had superior situational awareness than the Raptor and that JSF pilots are able to see in one display everything going on around their aircraft for vast distances along with being seen by other allied aircraft, ground forces, and ships. Brown went on to acknowledge that the JSF requires "trained, very proficient, and ready" aircrews; that it is extremely hard to detect and track with either radar, infrared, or electronic warfare capability; that it will outclass any jet fighter currently in production including those from Chinese and Russian competitors, and that the F-35 is the RAAF's right aircraft well into the future. Proponents such as RAAF Squadron Leader Andrew Jackson says JSF can penetrate sophisticated defenses without great risk to pilots, that the JSF gives the pilot the ability to think about the entire fight instead of their small segment of the battle, and that the JSF was not designed to be a dogfighting super weapon.[29]

Another JSF supporter Rep. Bob Baldwin (LIB—Paterson, NSW), who is also the Parliamentary Secretary to the Minister of the Environment, praised the JSF's business investment at Williamstown, NSW, for bringing jobs and enabling upgrading of runways and facilitating new building construction.[30]

In contrast, JSF critics such as backbench Liberal MP Dennis Jensen, who is a physicist by training and has worked at the Defence Department's Defence Science and Technology Organisation (DSTO), say that JSF is a "dud decision" and that "This aircraft is replete with problems." Jensen has also dismissed Abbott's contention that individual JSF aircraft would only cost about $A 90 million each, contending his calculations project per aircraft costs as $A 194 million. He and other JSF critics also maintain that the JSF could be outmaneuvered in a dogfight by fourth-generation jets.[31]

This debate is likely to continue, although it appears that there is enough support in Australia across the political spectrum for the JSF to continue despite the cost overruns, repeated production delays, and financial problems such as a projected 2014–2015 budget deficit of nearly $A 30 billion which is expected to gradually decline, but remain for several years affecting the then Abbott Government's adverse poll standings in early 2015 showing it trailing the opposition Labour Party, due to the JSF's significant presence in many areas of Australia and concern over Australia's ability to meet emerging aerospace threats from Southeast Asia. This situation has continued through the Malcolm Turnbull and Scott Morrison governments despite the factional strife plaguing these governments.[32] Australia will have to make these decisions in the context of an East Asian security environment seeing significant increases in defense spending by various regional countries that includes advanced fighter aircraft such as the French Rafale and Russian SU-30. The aging of RAAF's F/A-18 A/B fleet demonstrated in Table 5.7 will also influence Australia's purchase of the JSF.

China's growing air and maritime warfare capabilities must be taken into account including the 2012 deployment of J-15 fighter flight trials on the aircraft carrier *Liaoning*, ongoing efforts to develop a carrier battle

Table 5.7 Aging RAAF F/A-18 A/B fighters[33]

Year	*Number (2016)*	*Age (2016)*	*Age (2023)*
1985	6 (1xAl 5xB)	31	38
1986	12 (12xA)	30	37
1987	14 (7xA; 7xB)	29	36
1988	24 (20xA; 4xB)	28	35
1989	11 (11xA)	27	34
1990	4 (4xA)	26	33

group, efforts to achieve anti-access air denial capability against American forces, and attempts by other Asian nations to develop fixed and rotary-winged aircraft for various air and naval capabilities.[34]

The Chinese Air Force, commonly known as the People's Liberation Army Air Force (PLAAF), also includes an estimated 500+ fourth-generation J-10 and J-11 fighters, 73 Russian-built SU-30 fighters, an estimated 300 SU-27 fighters, and is beginning development of the fifth-generation Chengdu J-20 stealth fighter and the J-31 Shenyang fighters which may become operational around 2020. The PLAAF is increasing its holdings of airborne warning aircraft, and Unmanned Combat Aerial Vehicle (UCAV) aircraft to increase its ability to thwart Australian or other US allied attempts to restrict Chinese assertiveness in Southeast Asia. PLAAF has also acquired large amounts of fourth-generation and fourth-generation plus fighters with stand-off active radar air-to-air missiles or precision-guided air-to-surface missiles. It is estimated that PLAAF and PLAN will have nearly 600 fourth generation of better aircraft by the end of the 2010s with these aircraft and weapons systems consisting of Chinese, Israeli, and Russian components.[35]

Recognizing the role of strike aircraft is a critical component of Australian military airpower doctrine as the following passage illustrates:

> The core air power role of strike aligns with the ADF (Australian Defence Force) warfighting function of force application. Strike is the ability to attack with the intention of damaging, neutralizing or destroying a target.
>
> Strike can employ lethal or nonlethal, and kinetic or non-kinetic means to create the desired physical and/or cognitive effect on the adversary. It has particular value for the use of air power as a broader deterrent or coercive instrument. The demonstrated capacity to strike an adversary allows the application of a range of strategies, such as a diplomatic warning or show of force, through to the actual use of force. Strike can therefore be used to deter or coerce the adversary, degrade, neutralize or destroy an adversary's

> war-making capabilities, or disrupt or deny courses of action. Strike missions are proactive and offensive in nature and may be used to take the initiative, gain surprise and minimise opposition to friendly operations. Like all air power roles, strike can achieve synergistic effects when employed in combination with other roles.[36]

Australia's probable eventual deployment of the JSF in the next few years due to the extensive human and financial capital and infrastructure developments bringing this about will occur in a security environment in which it will seek to maintain its historic security ties with the United States. In addition, Australia will also seek to maintain its strong trading relations with China while hedging against increasing Chinese power and assertiveness in the South China Sea; increase security cooperation with Japan; maintain cooperation with Indonesia while guarding against concerns it has about that archipelagic country's long-term stability, and paying close attention to unstable security environments in neighboring Pacific Island countries such as East Timor, Papua New Guinea, and the Solomon Islands. Canberra will seek to balance these multifaceted traditional security concerns and determine what role the JSF and other military aircraft will play in promoting its strategic interests while governing parties such as the Coalition and ALP will seek to navigate between long-term domestic budgetary concerns and meeting Australia's far-flung maritime and geopolitical interests. All of these concerns, and the means to pay for them, will need to be included in the 2015 Defence White Paper expected from the Abbott Government.[37]

Although the 2015 Defence White Paper had not been published in June 2015, 269 public submissions on its potential content were been submitted as of February 2015 when some of these submissions commenting on the JSF. Criticism of the JSF was provided by Rodney Couch of Murwillumbah, NSW, who mentioned his 22 years of service as an F-111 technician in the RAAF. Couch contended that the JSF acquisition was becoming too expensive and that Australia should purchase more F-18 Super Hornets, asserting that with upgraded engines these aircraft would have supercruise capability, increased range, a 50% radar signature reduction compared to the JSF, be over $100 million cheaper than the JSF, and that if the JSF loses an engine when out at sea then the entire aircraft is lost.[38]

Another example of Australian defense crowdsourcing policy advocacy toward the F-35 is provided in an October 2014 submission by the Australian subsidiary of Northrop Grumman. This submission notes

Australia's complex and evolving national security environment. It observes that the incorporation of fifth-generation assets such as the JSF into the RAAF will transform how Australia prosecutes air power application and applies military force in the joint domain. It notes Australia will need to invest in integrated and comprehensive (Command, Control, Computers, Communications, Intelligence, Surveillance, and Reconnaissance [C4ISR]) capabilities to achieve maximum leverage of fifth-generation platform capabilities. It also stresses how fifth-generation warfare will place increasing importance on interoperability to sense, understand, and orchestrate the battle space and that ADF needs to be sufficiently agile to take full advantage of all information and joint capabilities to gain decisive advantage in emerging combat environments.[39]

A January 2016 Australian National Audit Office (ANAO) report on the JSF positively noted that JSF expenditure was 21% below budget, that the first two JSF aircraft were delivered in 2014, that construction work on relevant facilities had begun at RAAF Williamstown, and that the first Australian pilot had completed training and the second pilot began training in May 2015. Concern was expressed that that Block 3F software development was slipping against the manufacturer's baseline, that Australia's sustainment solution was immature, and that establishing requisite communications, infrastructure, and technology for the JSF remains a primary concern.[40]

The Australian Defence White Paper was released in February 2016 by Defence Minister Senator Marise Payne (LIB—NSW). This document stressed Australia's three key strategic objectives:

- Deterring, denying, and defeating any attempt by a hostile country or non-state actor to attack, threaten or coerce Australia;
- Supporting the security of maritime South East Asia and supporting the governments of Papua New Guinea, Timor-Leste and Pacific Island Countries to build and strengthen their security; and
- Providing meaningful contributions to global responses to address threats to the rules-based global order threatening Australia and its interests.[41]

This document stressed the important role the JSF would play in fulfilling RAAF capabilities to address emerging Australian security needs.[42]

The JSF program continued to progress despite turmoil in Australia's governing Liberal and National Party coalition. Prime Minister Tony

Abbott was ousted on September 14, 2015, in an intraparty factional dispute by Malcolm Turnbull (LIB—Wentworth, NSW). A few months after this, Australian voters held their triennial parliamentary election on July 2, 2016. This resulted in the Coalition government narrowly being returned to power in results taking several days to finalize while showing increasing electoral dissatisfaction with established political parties and the emergence of numerous minor political parties who gained parliamentary seats.[43]

Prior to the July 2016 election, the Australian Parliament's Senate Foreign Affairs, Trade, and Defence References Committee was directed by the chamber on December 2, 2015, to examine the JSF program. Following the election, this investigation was reactivated and the committee as given a new reporting date of October 13, 2016. It held a public hearing on March 22, 2016, receiving 57 submissions supporting or opposing the JSF from a variety of individuals and organizations.[44] Lockheed Martin Chief Executive Raydon W. Gates argued:

> The F-35 offers the unprecedented ability to rapidly deploy and penetrate enemy battlespace, seize the initiative, and deter an opposing force. Its unique blend of 5th generation capabilities provides numerous military options in the presence of advanced, integrated enemy air-defence environments. As the only 5th Generation multirole fighter on the international market, the F-35 transforms the battlespace. It allows for a shift in doctrine that takes advantage of the full capability of the F-35 Lightning II, from stealthy surveillance to the full spectrum of combat operations—in highly integrated contested air-defence environments. Representing a true quantum leap in fighter capability, the F-35 will ensure the RAAF's asymmetric advantage.[45]

Continuing Air Power Australia's criticism of the JSF was expressed by David Goon, who questioned whether the JSF's flight capabilities actually exceed those of the F-16 and F/A-18 and whether this would satisfactorily address emerging Australian needs. He also questioned JSF's stealth performance and questioned whether it could survive a battlefield interdiction environment featuring medium- and short-range SAMs and antiaircraft artillery. Submitter David Archibald claimed the JSF was a subsonic aircraft in air intercept and ground attack missions, that it is incapable of achieving supercruise, and that it has low instantaneous and sustained turn rates, low acceleration, and limited combat endurance.[46]

These criticisms were challenged by the airpower advocacy organization the Sir Richard Williams Foundation whose submission by Chair E.J. McCormack maintained stealth involves ensuring access instead of preventing detection. This organization also stressed that true stealth means a pilot is able to choose where to operate, when to engage or disengage, when to be seen or not seen, and reducing adversarial situational awareness to almost zero, consequently providing improved mission success and enhanced survivability. Australian Strategic Policy Institute (ASPI) Defense and Strategy Program Director Andrew Davis stressed the JSF was meeting its stealth design targets according to existing testing.[47]

ASPI went on to stress that the Defence Department should prepare a hedging strategy providing for possible further delays in JSF delivery and that failing to do so could significantly limit the range of possible responses in the early 2020s producing the possibility of a capability gap. The Defence Department acknowledges that Canberra is expected to receive the two more JSFs in late 2018 with initial operational capacity being achieved between 2018 and 2020. Delivery of the 72 JSFs to RAAF Williamstown and RAAF Tindall NT is as follows:

- 2 in 2014;
- 8 in 2018;
- 8 in 2019;
- 15 in 2020;
- 15 in 2021;
- 15 in 2022; and
- 9 in 2023.[48]

This parliamentary committee's report also addressed whether Australia should purchase other international jet fighters such as the US F-22 Raptor, Sweden's JAS 39-E Gripen, the European Union's Eurofighter, and France's Dassault Rafale. However, the Defence Department stressed that the F-22 did not meet Australian multirole requirements because of its limited air-to-surface capability and US refusal to sell the F-22 to other countries, the limited ability of other fighters to be modernized during their service life to defeat more complex threats beyond 2030, their absence of stealth capabilities comparable to the Russian PAK-FA and Chinese J-20 and J-31 aircraft, and the JSF's ability to meet governmental expectations over multiple years of testing through thousands of simulation runs and multiple human-in-the-loop mission simulator experiments.[49]

Consequently, the Committee, chaired by Alex Gallacher (ALP—SA) and Chris Black (LIB—WA), recommended continuing purchase of JSF with the Defence Department developing a hedging strategy to address the possibility of a capability gap stemming from further acquisition delays with this strategy be completed by 2018 and implemented by 2019. The Committee also recommended that the Defence Department develop a sovereign JSF industrial capability strategy to ensure Australian aircraft can be maintained and supported without excessive reliance on other countries and that the government work to establish Australia as the JSF's Asia-Pacific maintenance and sustainment hub. Disagreement and concern over the JSF were reflected in comments by Green Party and Nick Xenophon (SA), team members of this committee.[50]

In December 2016, Air Vice Marshall Leigh Gordon, the head of Australian JSF program activity, announced the following Australian JSF events would occur during the first quarter of 2017:

- Contract announcement for low-rate initial production including Australia's next eight JSF's: January.
- First JSF maintenance cadre starts training in the United States: February
- JSF appears at Avalon, Victoria International Air Show: February 28–March 5
- Celebration for new Australian JSF Off-Board Information System Centre at RAAF Base Williamstown.

Additional significant developments for Australia's JSF include conducting the first ever in-flight weapons release during an exercise at Luke Air Force Base (AFB), AZ, on December 14, 2016; employing a GBU-12500 lbs Paveway II LGB during a sortie over the Barry Goldwater Range west of Luke AFB; and the ALIS achieving Cybersecurity Accreditation from the RAAF and the Defence Chief Information Officer Group.[51]

Canberra's efforts to enhance its defense industrial capability concerning the JSF and other weapons system may be helped by the December 5, 2016, establishment of the Centre for Defence Industry Capability in Adelaide. Led by Defence Industry Minister Christopher Pyne (LIB—Sturt, SA), this organization will receive $A 230 million over the next decade to work with the Defence Department to enhance governmental support to relevant industries for business improvement, skills development, export and supply chains, supplier continuous improvement, defense market preparedness, and defense innovation proposal submission to facilitate enhanced alignment between defense capability needs and industry investment in future skill requirements.[52]

Noteworthy 2017 Australian JSF developments included Australia being awarded the Asia-Pacific F-35 Regional Warehouse as part of the F-35 Global Support Solution in September 2017. British Aerospace (BAE) Systems Australia is the successful company with the warehouse being located at RAAF Williamstown and 2018 remains slated as the year the F-35A arrives in Australia.[53] In October 2017, the Australian Signals Directorate revealed that nearly 30 gigabytes of restricted information on the JSF, P-8 submarine hunters, Joint Direct Attack Munitions, and Australian naval vessels had been stolen in a hacking attack believed to be of Chinese origin. The hacker had access to this information for three months before it was discovered.[54]

November 2017 saw the third Australian JSF roll off Lockheed Martin's assembly line in Fort Worth and Gordon announced that the first aircraft arrival is due in December 2018 with Initial Operating Capability being achieved by the end of 2020. In addition, the company SRC Aus has won an $A 17 million defense contract called Ghosthawk to produce mission data sets for emerging fifth-generation air force systems such as the JSF. These data sets will cover weapons, radars, and other aircraft and electronic warfare which will be integrated with the JSF's onboard suite of advanced mission sensors to enhance warfighter situational awareness.[55]

The desire to maintain oversight of Australia's involvement in the JSF and to regulate expenses is reflected in the late 2017 initiation of an Australian National Audit Office inquiry on the JSF's service and sustainment planning. This agency is currently accepting input on these aspects of the JSF and will issue its report in October 2018. Three JSFs were delivered to Australia during the first quarter of 2018, with five additional aircraft expected to arrive by the end of 2018.[56]

Australia is a critically important US ally in the southern hemisphere and its close proximity to the Indian and Pacific Oceans, South China Sea, and Asia-Pacific trade routes make it an integral player in the Asia-Pacific region's emerging geopolitical and strategic architectures. It has had successes and failures experienced by this program during its history. It is highly probable that the JSF will become part of Canberra's force projection capabilities and impact Australian power projection and combat striking power capabilities in many areas of the Asia-Pacific and Indian Ocean regions.

Notes

1. See Alan Stephens, *Australian Centenary History of Defence: Volume 2: The Royal Australian Air Force*, (Melbourne: Oxford University Press, 2001); Eric Andrews, *Australian Centenary History of Defence: Volume 5: The Department of Defence*, (Melbourne: Oxford University Press, 2001); Greg Sheridan, *The Partnership: The Inside Story of the US-Australian Alliance Under Bush and Howard*, (Sydney: University of New South Wales Press, 2006); John Charles Blaxland, *Strategic Cousins: Australian and Canadian Expeditionary Forces and the British and American Empires*, (Montreal: McGill-Queens University Press, 2006); Jeffrey D. McCausland, *The United States and Australia at the Start of the 21st Century*, (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2007); http://purl.access.gpo.gov/GPO/LPS80148; Accessed December 22, 2017; and Royal Australian Air Force, *The Australian Experience of Air Power*, 2nd ed. (Canberra: Air Force Headquarters, 2013); http://airpower.airforce.gov.au/APDC/media/PDF-Files/Doctrine/AAP1000-H-The-Australian-Experience-of-Air-Power-2nd-Edition.pdf; Accessed December 21, 2017.
2. Australia. Defence Acquisition Organisation. *Defence New Major Capitol Equipment Proposals 1998–2003*, (Canberra: Defence Acquisition Organisation, 1999).
3. David Watt, *The Joint Strike Fighter: Overview and Status*, (Canberra: Australia Parliamentary Library, 2012); 7; http://parlinfo.aph.gov.au/parlInfo/download/library/prspub/1804322/upload_binary/1804322.pdf;fileType=application%2Fpdf#search=%22Defence%20%202010s%20 2012%22; Accessed December 21, 2017.
4. Australia, Department of Defence, *Defence 2000: Our Future Defence Force*, (Canberra: Department of Defence, 2000): 84–88. http://www.defence.gov.au/publications/wpaper2000.PDF; Accessed February 9, 2017.
5. See Australian National Audit Office, *Planning and Approval of Defence Major Capital Equipment Projects, Performance Audit No. 48 2008–09*, (Barton, ACT: Australian National Audit Office, 2009): 88–89; https://www.anao.gov.au/sites/g/files/net4181/f/ANAO_Report_2008-2009_48.pdf; Accessed February 21, 2017; Australia, Parliament, Joint Standing Committee on Foreign Affairs, Defence, and Trade, *Inquiry into Australia's Defence Relations With the United States*, (Canberra: Commonwealth of Australia, 2006): 23–39; http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=jfadt/usrelations/report.htm; Accessed February 11, 2017; John Birkler and John Graiser et al., *Assessing Competitive Strategies*

for the Joint Strike Fighter: Opportunities and Options, (Santa Monica: Rand Corporation, 2001): 18; http://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1362/MR1362.ch2.pdf; Accessed February 17, 2017; and Watt, 3–4.

6. Adam Lockyer, "The Logic of Interoperability: Australia's Acquisition of the F-35 Joint Strike Fighter," *International Journal*, 68 (1)((Winter 2012–2013): 81–82; https://doi.org/10.1177/002070201306800106; Accessed February 11, 2017.
7. See Patrick Walters, "Strategy on Iraq to Stay," *The Weekend Australian*, (November 11, 2006): 2; and U.S. Department of State, *Defense Joint Strike Fighter Program: Agreement Between the United States and Australia Supplementing the Memorandum of Understanding of January 17, 2001*, (Washington, DC: Department of State, 2013(?); http://purl.fdlp.gov/GPO/gpo39159; Accessed February 20, 2017.
8. Patrick Walters, "New Defence Plan Based on Self-Reliance," *The Australian*, (March 2, 2007): 8.
9. Australia, Parliament, House of Representatives, *Hansard*, 41st Parliament, 1st Session, No. 3 (February 28, 2007): 192; http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/2007-02-28/toc_pdf/5271-3.pdf;fileType=application%2Fpdf#search=%22chamber/hansardr/2007-02-28/0000%22; Accessed February 21, 2017.
10. Ibid., *$6 Billion to Maintain Australia's Regional Air Superiority*, (Canberra: Department of Defence, 2007): 1; http://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/KZEO6/upload_binary/kzeo61.pdf;fileType=application%2Fpdf#search=%22media/pressrel/KZEO6%22; Accessed February 21, 2017.
11. Ibid., *Review of Australia's Air Combat Capability*, (Canberra: Department of Defence, 2008): 1; http://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/G0PP6/upload_binary/g0pp61.pdf;fileType=application%2Fpdf#search=%22media/pressrel/G0PP6%22; Accessed February 21, 2017.
12. Andrew Davies, *How Much Will the Joint Strike Fighter Cost Australia?*, (Barton, ACT: Australian Strategic Policy Institute, 2008): 1, 6–7; https://www.aspi.org.au/report/how-much-will-joint-strike-fighter-cost-australia; Accessed June 5, 2018.
13. Australia, Parliament, House of Representatives, *Hansard*, 42nd Parliament, 1st Sess., No. 13 (September 24, 2008): 8436; http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/2008-09-24/toc_pdf/6193-3.pdf;fileType=application%2Fpdf#search=%22chamber/hansardr/2008-09-24/0000%22; Accessed February 21, 2017.
14. *Defending Australia in the Asia-Pacific Century: Force 2030*, (Canberra: Department of Defence, 2009): 78–79; http://www.defence.gov.au/whitepaper/2009/docs/defence_white_paper_2009.pdf; Accessed February 10, 2017.

15. Ibid., *F-35 Joint Strike Fighter: Australia's Next Generation of Air Power*, (Canberra: Department of Defence, 2009): 1; https://www.dmtc.com.au/news/f-35-joint-strike-fighter-australias-next-generation-air-power/; Accessed June 5, 2018.
16. See Watt, 5; and Australian National Audit Office, *2011–12 Major Projects Report: Defence Material Organisation*, (Barton, ACT: Australian National Audit Office, 2012): 57; https://www.anao.gov.au/sites/g/files/net4181/f/201213%20Audit%20Report%20No%2015.pdf; Accessed February 21, 2017.
17. David Watt, *Joint Strike Fighter Budget Review 2012–13 Index*, (Canberra: Australian Parliamentary Library, 2012): 1–2; http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201213/StrikeFighter; Accessed February 21, 2017.
18. Australia, Parliamentary Joint Committee on Foreign Affairs, Defence and Trade (Defence Subcommittee), *Department of Defence Annual Report 2010–2011*, (Canberra: Commonwealth of Australia, 2012): 54–55; http://parlinfo.aph.gov.au/parlInfo/download/committees/commjnt/2dbe833f-6e45-4a8a-b615-8745dd6f148e/toc_pdf/Parliamentary%20Joint%20Committee%20on%20Foreign%20Affairs,%20Defence%20and%20Trade_2012_03_16_898_Official.pdf; Accessed February 21, 2017.
19. Lockyer, 71–73.
20. See Australia, Department of Industry, Science, and Innovation, *New Air Combat Capability Industry Support Program* (Canberra: Department of Industry, Science, and Innovation, 2017): 1–5; https://www.business.gov.au/assistance/new-air-combat-capability-industry-support-program-nacc-isp; Accessed June 5, 2018 for information on JSF Australian defence grant recipients from Fiscal Years 2011–2012 to 2016–2017; Australia, Parliament, *Senate Standing Committee on Foreign Affairs, Defence, and Trade Inquiry into the Planned Acquisition of the F-35II Lightning Joint Strike Fighter: Department of Defence Written Submission #55*, (Canberra: Department of Defence, 2016): 10; https://www.aph.gov.au/DocumentStore.ashx?id=13d32d90-5222-474b-a99d-9523fe223cff&subId=409757; Accessed February 17, 2017; Mike Yeo, "Australian F-35 Industry Involvement Ramping Up," *Asia-Pacific Defence Reporter*, 43 (1)(February 2017): 18–25.
21. Ibid., *New Air Combat Capability-Industry Support Program*, (Canberra: Australia Department of Industry, 2018): 1–5.
22. Stockholm International Peace Research Institute, *SIPRI Military Expenditure Database*, (Stockholm: Stockholm International Peace Research Institute, 2018): http://www.sipri.org/research/armaments/milex/milex_database; Accessed June 5, 2018.

23. Ibid.
24. Ibid.
25. See Ibid., *SIPRI Arms Transfers Database*, (Stockholm: Stockholm International Peace Research Institute, 2018): http://www.sipri.org/databases/armstransfers; Accessed June 5, 2018; and *The Modern Defense Industry*, Richard A. Bitzinger, ed. (Santa Barbara: ABC-CLIO, 2009).
26. Ibid., *SIPRI Arms Transfers Database*.
27. Sanu Kainikara, *The Art of Airpower: Sun Tzu Revisited*, (Canberra: Air Power Development Centre, 2012): 65; http://airpower.airforce.gov.au/APDC/media/PDF-Files/Contemporary%20AirPower/AP18-The-Art-of-Air-Power-Sun-Tzu-Revisited.pdf; Accessed February 20, 2017.
28. Australia, Department of Defence, *Prime Minister and Minister for Defence: Joint Media Release: F-35 Joint Strike Fighters to Transform Australia's Air Combat Capability*, (Canberra: Department of Defence, 2014): Video access at: http://video.defence.gov.au/play/3329#; Accessed February 21, 2017.
29. Brendan Nicholson, "Visionary Fighter A Home Run," *The Australian*, (April 24, 2014): 9.
30. Parliament of Australia, House of Representatives, *Hansard*, 44th Parliament, 1st Sess., No. 7, (May 26, 2014): 4263; http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/6f011bde-9138-44d1-93a9-08f7c4113f58/toc_pdf/House%20of%20Representatives_2014_05_26_2474_Official.pdf;fileType=application%2Fpdf#search=%22chamber/hansardr/6f011bde-9138-44d1-93a9-08f7c4113f58/0000%22; Accessed February 21, 2017.
31. See Ibid., Parliament of Australia, "Dr. Dennis Jensen, MP," http://www.aph.gov.au/Senators_and_Members/Parliamentarian?MPID=DYN#biography; Accessed February 11, 2017; and Parliament of Australia, House of Representatives, *Hansard*, 44th Parliament, 1st Sess., No. 9, (June 16, 2014): 6151–6152, http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansardr%2F128494f5-3b78-4d37-9efd-c8ccbc721e70%2F0396%22; for Jensen's speech denouncing the JSF; Accessed February 11, 2017
32. See Commonwealth of Australia, *Budget 2014–2015: Overview*, (Canberra: Commonwealth of Australia, 2014): 1, 36; http://www.budget.gov.au/2014-15/content/overview/download/Budget_Overview.pdf; Accessed February 18, 2017; and Galaxy Research, "Polling 4/5 February 2015: Turnbull Could Lift Coalition Support," (West Chatswood, NSW: Galaxy Research, 2015): http://www.galaxyresearch.com.au/45-february-2015/; Accessed February 21, 2017.
33. Australia, Parliament, Senate Foreign Affairs, Defence, and Trade References Committee, *Planned Acquisition of the F-35 Lightning II (Joint*

Strike Fighter, (Canberra: Australia Parliament Senate Foreign Affairs, Defence, and Trade References Committee, 2016): 40; http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/JointStikeFighter/~/media/Committees/fadt_ctte/JointStikeFighter/report.pdf; Accessed February 20, 2017.

34. See International Institute of Strategic Studies, *The Military Balance 2015*, (London: IISS, 2015): 207–302; and Richard Bitzinger, *Singapore Airshow: The Joint Strike Fighter and the Asian Arms Market*, http://www.rsis.edu.sg/wp-content/uploads/2014/07/CO14025.pdf; Accessed February 18, 2017.
35. See V.K. Bhatia, *Airpower Across the Himalayas: A Military Appreciation of the Chinese and Indian Air Forces*, (Singapore: S. Rajaratnam School of International Studies, 2013): 2–3; http://www.rsis.edu.sg/wp-content/uploads/2014/07/PB131201_Airpower_Across_Himalayas.pdf; Accessed February 18, 2017; Bitzinger, 1–2; Richard A. Bitzinger, "Military Modernization in Asia," in *Strategy in Asia: The Past, Present, and Future of Regional Security*, Thomas G. Mahnken and Thomas Blumenthal, eds., (Stanford, CA: Stanford University Press, 2014): 168–170; and *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, Richard P. Hallion, Roger Cliff, and Phillip G. Saunders, eds., (Washington, DC: National Defense University Press, 2012): http://ndupress.ndu.edu/Portals/68/Documents/Books/chinese-air-force.pdf; Accessed February 18, 2017.
36. Royal Australian Air Force, *The Air Power Manual*, 6th ed., (Canberra: Air Force Headquarters, 2013): 56; http://airpower.airforce.gov.au/APDC/media/PDF-Files/Doctrine/AAP1000-D-The-Air-Power-Manual.pdf; Accessed February 19, 2017.
37. See Sainu Kainikara and Tony Forestier, *Air Power for Australia's Security: More Than the Three Block War*, (Tuggeranong, ACT: RAAF Airpower Development Centre, 2007); http://airpower.airforce.gov.au/APDC/media/PDF-Files/CAF%20Occasional%20Papers/CAF01-Air-Power-for-Australia-s-Security-More-Than-the-Three-Block-War.pdf; Accessed February 19, 2017; John Blackburn, "The Future for Aerospace Forces," *Security Challenges*, 9 (2)(2013): 67–74; https://www.regionalsecurity.org.au/Resources/Files/SC9-2Blackburn.pdf; Accessed February 21, 2017; Chris Brookes, "Japan's 2013 National Security Strategy: The Strategic Implications for Australia," *Australian Defence Force Journal*, 194 (July/August 2014): 24–30; http://www.defence.gov.au/adc/adfj/Documents/issue_194/194_2014_Jul_Aug.pdf; Accessed June 5, 2018; Gary Waters, *Pressing Issues for the 2015 Defence White Paper*, (Kingston, ACT: The Kokoda Foundation, 2014); http://www.kokoda-foundation.org/Resources/Documents/DP01WhitePaperReportWeb.pdf;

Accessed February 19, 2017; and Williamson Murray and Peter Mansoor, "U.S. Grand Strategy in the 21st Century: The Case for Continental Commitment," *Orbis*, 59 (1)(2015): 33–34; https://doi.org/10.1016/j.orbis.2014.11.003; Accessed February 19, 2017. For the 2016 Australian Defence White Paper and public comments for this consultation process, see Australia, Department of Defence, http://defence.gov.au/Whitepaper/default.asp; Accessed February 21, 2017.

38. Rodney Couch, *Submission to the 2015 Defence White Paper*, (Canberra: Department of Defence, September 23, 2014): 1; http://www.defence.gov.au/Whitepaper/docs/049-Couch.pdf; Accessed February 19, 2017.
39. Ken Crowe, *Northrup Grumman Australia, WP15 Defence White Paper Submission-October 2014*, (Canberra: Department of Defence, 2014): 6–7; http://www.defence.gov.au/Whitepaper/docs/026-NorthropGrumman.pdf; Accessed February 19, 2017.
40. Australian National Audit Office, *2014–15 Major Projects Report: Department of Defence*, (Canberra: ANAO, 2016): 149–151; https://www.anao.gov.au/work/major-projects-report/2014-15-major-projects-report; Accessed February 20, 2017.
41. See Australia, Department of Defence, *2016 Defence White Paper*, (Canberra: Department of Defence, 2016): 17–18; (Accessed February 20, 2017); and Bert Chapman, "Geopolitics of the 2016 Australian Defense White Paper and its Predecessors," *Geopolitics, History, and International Relations*, 9 (1)(2017): 17–67; http://docs.lib.purdue.edu/lib_fsdocs/134/; Accessed February 20, 2017).
42. *2016 Defence White Paper*, 19, 95.
43. See Jason Scott, "Australian Prime Minister Tony Abbott as Party Votes to Remove Him" *The National Post*, (September 14, 2015): http://news.nationalpost.com/news/world/australian-prime-minister-ousted-in-internal-party-challenge-replaced-by-former-party-leader; Accessed February 20, 2017; and Australian Electoral Commission, *Tally Room: 2016 Federal Election-House of Representatives*, (Canberra: Australian Electoral Commission, 2016): 1–2; http://results.aec.gov.au/20499/Website/HouseDefault-20499.htm; Accessed February 20, 2017.
44. Australia, Parliament, Senate Foreign Affairs, Defence, and Trade References Committee, *Joint Strike Fighter*, (Canberra: Senate Foreign Affairs, Defence, and Trade Committee, 2016): 1; http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/JointStikeFighter; Accessed February 20, 2017; and Ibid., *Submissions Received by the Committee*, http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/Joint_fighter/Submissions; Accessed February 20, 2017.

45. Ibid., *Lockheed Martin Submission to F-35 Inquiry*, (Canberra: Senate Standing Committee on Foreign Affairs, Defence, and Trade, March 22, 2016): 6–7; http://www.aph.gov.au/DocumentStore.ashx?id=19ac912f-b39e-4b97-b1ab-5a1b48162be0&subId=409405; Accessed February 20, 2017.
46. Ibid., *Planned Acquisition of the F-35 Lightning II (Joint Strike Fighter)*, 19, 21; https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/JointStikeFighter/Report; Accessed February 20, 2017.
47. Ibid., 22–23.
48. Ibid., 39, 38.
49. Ibid., 47–48.
50. Ibid., 69–71, 74–81. For parliamentary debate on report findings see Australia, *Parliamentary Debates Senate Official Hansard*, 45th Parliament, 1st Sess., no. 3, (13 October 2016): 1823–1827; http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansards/880818e0-3c94-4ae9-90ac-07967f4ec995/toc_pdf/Senate_2016_10_13_4471_Official.pdf;fileType=application%2Fpdf#search=%22chamber/hansards/880818e0-3c94-4ae9-90ac-07967f4ec995/0000%22; Accessed February 20, 2017.
51. Australia, Department of Defence, *Lightning News*, December 2016: 4–5; http://www.defence.gov.au/casg/Multimedia/Final_QUARTERLY_LIGHTNING_NEWS_BULLETIN_-_DEC_2016__3_-9-7859.pdf; Accessed February 20, 2017.
52. See Ibid., "Centre for Defence Industry Capability Opens in Adelaide," (Canberra: Ministry of Defence, 5 December 2016): 1; https://www.minister.defence.gov.au/minister/christopher-pyne/media-releases/centre-defence-industry-capability-opens-adelaide; Accessed February 20, 2017; and https://www.business.gov.au/centre-for-defence-industry-capability; Accessed February 20, 2017.
53. "Message from Head JSF Division – AVM Leigh Gordon AM, CSM," *Lightning News*, (September 2017): 1–2; http://www.defense-aerospace.com/articles-view/verbatim/4/189267/raaf-provides-status-report-on-f_35-program.html. Accessed December 21, 2017.
54. Primrose Riordan, "Details of JSF, Sub Hunters Hacked," *The Australian*, (October 12, 2017): 5.
55. See "Message from Head JSF Division-AVM Leigh Gordon, AM, CSM," *Lightning News*, (December 2017): 1–2; http://www.defence.gov.au/casg/AboutCASG/OurStructure/Air/JointStrikeFighterDivision/JSFLightningNews_Dec17.aspx; Accessed December 21, 2017; and Australia, Department of Defence, "Ghosthawk Brings the JSF to Life in Australia," (Canberra: Department of Defence, 18 September 2017): 1;

https://www.minister.defence.gov.au/minister/christopher-pyne/media-releases/ghosthawk-brings-jsf-life-australia; Accessed December 21, 2017.

56. See Australian National Audit Office, *Joint Strike Fighter – Introduction into Service and Sustainment Planning*, (Canberra: Australian National Audit Office, 2017): https://www.anao.gov.au/work/performance-audit/joint-strike-fighter-introduction-service-and-sustainment; Accessed December 21, 2017; and Lockheed Martin, "Next Three F-35A Joint Strike Fighters Mission Ready, (9 April 2018): 1. http://www.jsf.mil/news/docs/20180409_Next_three_F-35A.pdf; Accessed June 5, 2018.

References

Andrews, Eric. *Australian Centenary History of Defence: Volume 5: The Department of Defence* (Melbourne: Oxford University Press, 2001).

Australia. Parliament. Senate Foreign Affairs, Defence, and Trade References Committee. *Lockheed Martin Submission to F-35 Inquiry #46*. http://www.aph.gov.au/DocumentStore.ashx?id=19ac912f-b39e-4b97-b1ab-5a1b48162be0&subId=409405. Accessed February 20, 2017.

Australia. Parliament. Senate Foreign Affairs, Defence, and Trade References Committee. *Submissions Received by the Committee*. http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/Joint_fighter/Submissions. Accessed February 20, 2017.

Australia. Defence Acquisition Organisation. *Defence New Major Capitol Equipment Proposals 1998–2003* (Canberra: Defence Acquisition Organisation, 1999).

———. Department of Defence. *Defence 2000: Our Future Defence Force* (Canberra: Department of Defence, 2000): 84–88. http://www.defence.gov.au/publications/wpaper2000.PDF. Accessed February 9, 2017.

———. Parliament. House of Representatives. Joint Standing Committee on Foreign Affairs, Defence, and Trade. *Inquiry into Australia's Defence Relations with the United States* (Canberra: Commonwealth of Australia, 2006): 23–39. http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=jfadt/usrelations/report.htm. Accessed February 11, 2017.

———. Department of Defence. *$6 Billion to Maintain Australia's Regional Air Superiority* (Canberra: Department of Defence, 2007a): 1. http://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/KZEO6/upload_binary/kzeo61.pdf;fileType=application%2Fpdf#search=%22media/pressrel/KZEO6%22. Accessed February 21, 2017.

———. Parliament. House of Representatives. *Hansard*, 41st Parliament, 1st Session, No. 3 (February 28, 2007b): 192. http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/2007-02-28/toc_pdf/5271-3.pdf;fileT

ype=application%2Fpdf#search=%22chamber/hansardr/2007-02-28/0000%22. Accessed February 21, 2017.
———. Department of Defence. *Review of Australia's Air Combat Capability* (Canberra: Department of Defence, 2008a): 1. http://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/G0PP6/upload_binary/g0pp61.pdf;fileType=application%2Fpdf#search=%22media/pressrel/G0PP6%22. Accessed February 21, 2017.
———. Parliament. House of Representatives. *Hansard*, 42nd Parliament, 1st Sess., No. 13 (September 24, 2008b): 8436. http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/2008-09-24/toc_pdf/6193-3.pdf;fileType=application%2Fpdf#search=%22chamber/hansardr/2008-09-24/0000%22. Accessed February 21, 2017.
———. Department of Defence. *Defending Australia in the Asia-Pacific Century: Force 2030* (Canberra: Department of Defence, 2009a): 78–79. http://www.defence.gov.au/whitepaper/2009/docs/defence_white_paper_2009.pdf. Accessed February 10, 2017.
———. Department of Defence. *F-35 Joint Strike Fighter: Australia's Next Generation of Air Power* (Canberra: Department of Defence, 2009b): 1. https://www.dmtc.com.au/news/f-35-joint-strike-fighter-australias-next-generation-air-power/. Accessed June 5, 2018.
———. Parliament. House of Representatives. Parliamentary Joint Committee on Foreign Affairs, Defence and Trade (Defence Subcommittee). *Department of Defence Annual Report 2010–2011* (Canberra: Commonwealth of Australia, 2012): 54–55. http://parlinfo.aph.gov.au/parlInfo/download/committees/commjnt/2dbe833f-6e45-4a8a-b615-8745dd6f148e/toc_pdf/Parliamentary%20Joint%20Committee%20on%20Foreign%20Affairs,%20Defence%20and%20Trade_2012_03_16_898_Official.pdf;fileType=application%2Fpdf#search=%22committees/commjnt/2dbe833f-6e45-4a8a-b615-8745dd6f148e/0000%22. Accessed February 21, 2017.
———. Department of Defence. *Prime Minister and Minister for Defence: Joint Media Release: F-35 Joint Strike Fighters to Transform Australia's Air Combat Capability* (Canberra: Department of Defence, 2014a): Video access at: http://video.defence.gov.au/play/3329#. Accessed February 21, 2017.
———. Parliament. House of Representatives. *Hansard*, 44th Parliament, 1st Sess., No. 7 (May 26, 2014b): 4263. http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansardr/6f011bde-9138-44d1-93a9-08f7c4113f58/toc_pdf/House%20of%20Representatives_2014_05_26_2474_Official.pdf;fileType=application%2Fpdf#search=%22chamber/hansardr/6f011bde-9138-44d1-93a9-08f7c4113f58/0000%22. Accessed February 21, 2017.
———. Parliament. House of Representatives. *Hansard*, 44th Parliament, 1st Sess., No. 9 (June 16, 2014c): 6151–6152. http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansardr%2F

128494f5-3b78-4d37-9efd-c8ccbc721e70%2F0396%22. Accessed February 11, 2017.

———. Department of Defence. "Centre for Defence Industry Capability Opens in Adelaide." (Canberra: Ministry of Defence, 5 December 2016a): 1. https://www.minister.defence.gov.au/minister/christopher-pyne/media-releases/centre-defence-industry-capability-opens-adelaide. Accessed February 20, 2017.

———. Department of Defence. *Defence White Paper 2016* (Canberra: Department of Defence, 2016b). http://defence.gov.au/whitepaper/default.asp. Accessed February 20, 2017.

———. Parliament. House of Representatives. *Senate Hansard*, 45th Parliament 1st Sess., no. 3 (October 13, 2016c): 1823–1827. http://parlinfo.aph.gov.au/parlInfo/download/chamber/hansards/880818e0-3c94-4ae9-90ac-07967f4ec995/toc_pdf/Senate_2016_10_13_4471_Official.pdf;fileType=application%2Fpdf#search=%22chamber/hansards/880818e0-3c94-4ae9-90ac-07967f4ec995/0000%22. Accessed February 20, 2017.

———. Parliament. Senate Foreign Affairs, Defence, and Trade References Committee. *Joint Strike Fighter* (Canberra: Senate Foreign Affairs, Defence, and Trade Committee, 2016d): 1. http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/JointStikeFighter. Accessed February 20, 2017.

———. Parliament. Senate Foreign Affairs, Defence, and Trade References Committee. *Planned Acquisition of the F-35 Lightning II (Joint Strike Fighter)* (Canberra: Australia Parliament, Senate Foreign Affairs, Defence, and Trade References Committee, 2016e): 40. http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/JointStikeFighter/~/media/Committees/fadt_ctte/JointStikeFighter/report.pdf. Accessed February 20, 2017.

———. Parliament. Senate Standing Committee on Foreign Affairs, Defence, and Trade. *Inquiry into the Planned Acquisition of the F-35II Lightning Joint Strike Fighter: Department of Defence Written Submission #55* (Canberra: Department of Defence, 2016f): 10. https://www.aph.gov.au/DocumentStore.ashx?id=13d32d90-5222-474b-a99d-9523fe223cff&subId=409757. Accessed February 17, 2017.

———. Department of Defence. "Ghosthawk Brings the JSF to Life in Australia." (Canberra: Department of Defence, September 18, 2017a): 1. https://www.minister.defence.gov.au/minister/christopher-pyne/media-releases/ghosthawk-brings-jsf-life-australia. Accessed December 21, 2017.

———. Department of Industry, Science, and Innovation. *New Air Combat Capability Industry Support Program* (Canberra: Department of Industry, Science, and Innovation, 2017b): 1–5. https://www.business.gov.au/assistance/new-air-combat-capability-industry-support-program-nacc-isp. Accessed June 5, 2018.

———. Department of Industry, Science, and Innovation. *Centre for Defense Industry Capability* (Canberra: Department of Industry, Science, and Innovation, 2018): 1–2. https://www.business.gov.au/centre-for-defence-industry-capability. Accessed February 20, 2017.

Australian Electoral Commission. *Tally Room: 2016 Federal Election-House of Representatives* (Canberra: Australian Electoral Commission, 2016): 1–2. http://results.aec.gov.au/20499/Website/HouseDefault-20499.htm. Accessed February 20, 2017.

Australian National Audit Office. *Planning and Approval of Defence Major Capital Equipment Projects, Performance Audit No. 48 2008–09* (Barton, ACT: Australian National Audit Office, 2009): 88–89. https://www.anao.gov.au/sites/g/files/net4181/f/ANAO_Report_2008-2009_48.pdf. Accessed February 9, 2017.

———. *2011–12 Major Projects Report: Defence Material Organisation* (Barton, ACT: Australian National Audit Office, 2012): 57. https://www.anao.gov.au/sites/g/files/net4181/f/201213%20Audit%20Report%20No%2015.pdf. Accessed February 21, 2017.

———. *2014–15 Major Projects Report: Department of Defence* (Canberra: ANAO, 2016): 149–151. https://www.anao.gov.au/work/major-projects-report/2014-15-major-projects-report. Accessed February 20, 2017.

———. *Joint Strike Fighter – Introduction into Service and Sustainment Planning* (Canberra: Australian National Audit Office, 2017). https://www.anao.gov.au/work/performance-audit/joint-strike-fighter-introduction-service-and-sustainment. Accessed December 21, 2017.

Bhatia, V.K. *Airpower Across the Himalayas: A Military Appreciation of the Chinese and Indian Air Forces* (Singapore: S. Rajaratnam School of International Studies, 2013): 2–3. http://www.rsis.edu.sg/wp-content/uploads/2014/07/PB131201_Airpower_Across_Himalayas.pdf. Accessed February 18, 2017.

Birkler, John, John Graiser, et al. *Assessing Competitive Strategies for the Joint Strike Fighter: Opportunities and Options* (Santa Monica: Rand Corporation, 2001): 18. http://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1362/MR1362.ch2.pdf. Accessed February 17, 2017.

Bitzinger, Richard. "Military Modernization in Asia." In *Strategy in Asia: The Past, Present, and Future of Regional Security*, edited by Thomas G. Mahnken and Thomas Blumenthal, 168–170 (Stanford, CA: Stanford University Press, 2014).

———. *Singapore Airshow: The Joint Strike Fighter and the Asian Arms Market.* http://www.rsis.edu.sg/wp-content/uploads/2014/07/CO14025.pdf. Accessed February 18, 2017.

Blackburn, John. "The Future for Aerospace Forces." *Security Challenges*, 9 (2) (2013): 67–74. https://www.regionalsecurity.org.au/Resources/Files/SC9-2Blackburn.pdf. Accessed February 21, 2017.

Blaxland, John Charles. *Strategic Cousins: Australian and Canadian Expeditionary Forces and the British and American Empires* (Montreal: McGill-Queen's University Press, 2006).

Brookes, Chris. "Japan's 2013 National Security Strategy: The Implications for Australia." *Australian Defence Force Journal*, 194 (July/August 2014): 24–30. http://www.defence.gov.au/adc/adfj/Documents/issue_194/194_2014_Jul_Aug.pdf. Accessed June 5, 2018.

Chapman, Bert. "Geopolitics of the 2016 Australian Defense White Paper and its Predecessors." *Geopolitics, History, and International Relations*, 9 (1) (2017): 17–67. http://docs.lib.purdue.edu/lib_fsdocs/134/. Accessed February 20, 2017.

The Chinese Air Force: Evolving Concepts, Roles, and Capabilities. Edited by Richard P. Hallion, Roger Cliff, and Phillip G. Saunders (Washington, DC: National Defense University Press, 2012). http://ndupress.ndu.edu/Portals/68/Documents/Books/chinese-air-force.pdf. Accessed February 18, 2017.

Commonwealth of Australia. *Budget 2014–2015: Overview* (Canberra: Commonwealth of Australia, 2014): 1, 36. http://www.budget.gov.au/2014-15/content/overview/download/Budget_Overview.pdf. Accessed February 18, 2017.

Couch, Rodney. *Submission to the 2015 Defence White Paper* (Canberra: Department of Defence, September 23, 2014): 1. http://www.defence.gov.au/Whitepaper/docs/049-Couch.pdf. Accessed February 19, 2017.

Crowe, Ken. *Northrup Grumman Australia, WP15 Defence White Paper Submission-October 2014* (Canberra: Department of Defence, 2014): 6–7. http://www.defence.gov.au/Whitepaper/docs/026-NorthropGrumman.pdf. Accessed February 19, 2017.

Davies, Andrew. *How Much Will the Joint Strike Fighter Cost Australia?* (Barton, ACT: Australian Strategic Policy Institute, 2008): 1, 6–7. https://www.aspi.org.au/report/how-much-will-joint-strike-fighter-cost-australia. Accessed June 5, 2018.

Galaxy Research. "Polling 4/5 February 2015: Turnbull Could Lift Coalition Support." (West Chatswood, NSW: Galaxy Research, 2015). http://www.galaxyresearch.com.au/45-february-2015/. Accessed February 21, 2017.

Kainikara, Sanu, and Tony Forestier. *Air Power for Australia's Security: More Than the Three Block War* (Tuggeranong, ACT: RAAF Airpower Development Centre, 2007). http://airpower.airforce.gov.au/APDC/media/PDF-Files/CAF%20Occasional%20Papers/CAF01-Air-Power-for-Australia-s-Security-More-Than-the-Three-Block-War.pdf. Accessed February 21, 2017.

———. *The Art of Airpower: Sun Tzu Revisited* (Canberra: Air Power Development Centre, 2012): 65. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Contemporary%20AirPower/AP18-The-Art-of-Air-Power-Sun-Tzu-Revisited.pdf. Accessed February 20, 2017.

Lockheed Martin. "Next Three F-35A Joint Strike Fighters Mission Ready." (9 April 2018): 1. http://www.jsf.mil/news/docs/20180409_Next_three_F-35A.pdf. Accessed June 5, 2018.

Lockyer, Adam. "The Logic of Interoperability: Australia's Acquisition of the F-35 Joint Strike Fighter." *International Journal*, 68 (1) (Winter 2012–2013): 81–82. https://doi.org/10.1177/002070201306800106. Accessed February 11, 2017.

McCausland, Jeffrey D. *The Other Special Relationship: The United States and Australia at the Start of the 21st Century* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2007). http://purl.access.gpo.gov/GPO/LPS80148. Accessed December 22, 2007.

"Message from Head JSF Division – AVM Leigh Gordon AM, CSM." *Lightning News* (September 2017): 1–2. http://www.defense-aerospace.com/articles-view/verbatim/4/189267/raaf-provides-status-report-on-f_35-program.html. Accessed December 21, 2017.

The Modern Defense Industry. Edited by Richard A. Bitzinger (Santa Barbara: ABC-CLIO, 2009).

Murray, Williamson, and Peter Mansoor. "U.S. Grand Strategy in the 21st Century: The Case for Continental Commitment." *Orbis*, 59 (1) (2015): 33–34. https://doi.org/10.1016/j.orbis.2014.11.003. Accessed February 19, 2017.

Nicholson, Brendan. "Visionary Fighter A Home Run." *The Australian* (April 24, 2014): 9.

Parliament of Australia. "Dr. Dennis Jensen, MP." http://www.aph.gov.au/Senators_and_Members/Parliamentarian?MPID=DYN#biography. Accessed February 11, 2017.

Riordan, Primrose. "Details of JSF, Sub Hunters Hacked." *The Australian* (October 12, 2017): 5.

Royal Australian Air Force. *The Air Power Manual*. 6th ed. (Canberra: Air Force Headquarters, 2013a): 56. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Doctrine/AAP1000-D-The-Air-Power-Manual.pdf. Accessed February 19, 2017.

———. *The Australian Experience of Air Power*. 2nd ed. (Canberra: Air Force Headquarters, 2013b). http://airpower.airforce.gov.au/APDC/media/PDF-Files/Doctrine/AAP1000-H-The-Australian-Experience-of-Air-Power-2nd-Edition.pdf. Accessed February 21, 2017.

Scott, Jason. "Australian Prime Minister Tony Abbott as Party Votes to Remove Him." *The National Post* (September 14, 2015). http://news.nationalpost.

com/news/world/australian-prime-minister-ousted-in-internal-party-challenge-replaced-by-former-party-leader. Accessed February 20, 2017.
See International Institute of Strategic Studies. *The Military Balance 2015* (London: IISS, 2015): 207–302.
Sheridan, Greg. *The Partnership: The Inside Story of the US-Australian Alliance Under Bush and Howard* (Sydney: University of New South Wales Press, 2006).
Stephens, Alan. *Australian Centenary History of Defence: Volume 2: The Royal Australian Air Force* (Melbourne: Oxford University Press, 2001).
Stockholm International Peace Research Institute. *SIPRI Arms Transfers Database* (Stockholm: Stockholm International Peace Research Institute, 2018a). http://www.sipri.org/databases/armstransfers. Accessed January 5, 2018.
———. *SIPRI Military Expenditure Database* (Stockholm: Stockholm International Peace Research Institute, 2018b). http://www.sipri.org/research/armaments/milex/milex_database. Accessed June 5, 2018.
U.S. Department of State. *Defense Joint Strike Fighter Program: Agreement Between the United States and Australia Supplementing the Memorandum of Understanding of January 17, 2001* (Washington, DC: Department of State, 2013(?). http://purl.fdlp.gov/GPO/gpo39159. Accessed February 20, 2017.
Walters, Patrick. "Strategy on Iraq to Stay." *The Weekend Australian* (November 11, 2006): 2.
———. "New Defence Plan Based on Self-Reliance." *The Australian* (March 2, 2007): 8.
Waters, Gary. *Pressing Issues for the 2015 Defence White Paper* (Kingston, ACT: The Kokoda Foundation, 2014). http://www.kokodafoundation.org/Resources/Documents/DP01WhitePaperReportWeb.pdf. Accessed February 19, 2017.
Watt, David. *Joint Strike Fighter Budget Review 2012–13 Index* (Canberra: Australian Parliamentary Library, 2012a): 1–2. http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201213/StrikeFighter. Accessed February 21, 2017.
———. *The Joint Strike Fighter: Overview and Status* (Canberra: Australia Parliamentary Library, 2012b): 7. http://parlinfo.aph.gov.au/parlInfo/download/library/prspub/1804322/upload_binary/1804322.pdf;fileType=application%2Fpdf#search=%22Defence%20%202010s%202012%22. Accessed December 21, 2017.

CHAPTER 6

JSF and Canada

Canada, like other JSF participant countries, has experienced a long and troubling history with the JSF. Canadian defense policy has historically been marked by its close geographic proximity to the United States and close security ties with Washington. At the same time, these ties have often produced sentiment in Canadian political rhetoric against close security cooperation with the United States and against investing sufficient resources into defense spending to enable Ottawa to have international credibility on defense policy issues. Such defense spending deficiencies have applied to governments headed by the Conservative and Liberal Parties. In 2006, when Canada's Conservative (Conservative Party of Canada [CPC]) Government led by Prime Minister Stephen Harper (Calgary Southwest, AB) came to power, Canada spent $14.905 billion on defense. After increasing to a peak of $18.313 billion in 2009, Ottawa's defense spending retreated to $15.275 billion in 2014 before rising to $19.837 billion in 2017 and from 1.1% to 1.3% of GDP between 2007 and 2017. In geopolitical terms, Canada has to balance its security interests with the United States including its possession of significant hydrocarbon resources; its traditional NATO alliance ties across the Atlantic; the need to defend its Arctic territories from potential Russian and US encroachments, along with its growing trading ties with Pacific Rim countries including China, Japan, and South Korea which has increased from CAN $8.902 billion in April 2017 to CAN $9.652 billion in April 2018.[1]

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_6

A recently published analysis of Canadian defense policy notes conflict between different armed forces branches and governmental willingness to invest in defense as this passage demonstrates:

> Since Canada can never hope to field a force that can act single-handedly against a major adversary, the question always becomes one of determining how much is enough. Although there have been efforts to tie defense structures to cost benchmarks such as a percentage of gross domestic product or percentage of federal government spending, these measures have never proven very useful. As a consequence, the Canadian military has inevitably been limited in scope and scale by the amount of money that successive governments have been willing to allocate to defence generally, and *the amount allocated has always been determined by political and financial considerations rather than by military ones.* With the widespread acceptance of the argument that any collective defence structures will be more than capable of handling domestic defence needs, Canadian defence procurement, unless diverted by political imperatives such as regional economic developments initiatives and industrial offsets, has generally consisted of a struggle between the Navy, Army and Air Force for the most high-end, high-tech and high-priced equipment that any given budget permits.[2]

Canadian defense acquisition has also been complicated by an extremely complex process involving agencies such as the Department of National Defence (DND); Public Services and Procurement Canada; Innovation, Science, and Economic Development Canada; and the Treasury Board of Canada Secretariat. Each of these agencies is involved in different aspects of the defense acquisition process and their historical antecedents date back to World War I.[3]

Chretien and Martin Governments

Initial Canadian participation in the JSF began during the Liberal Party (LIB) Governments of Prime Ministers Jean Chretien (Saint Maurice, QC) (1993–2003) and Paul Martin (LaSalle-Émard, QC) (2003–2006). The primary Canadian jet fighter during their governments was the CF-18 which is Ottawa's version of the US F-18 jet fighter. These fighters were originally purchased in the 1980s with their expected operational life expectancy lasting until 2003. The CF-18's life expectancy was extended to between 2017 and 2020 by a 2000 modernization program. On January 2, 1998, Chretien's Government signed a first-phase MOU to participate in the JSF program.[4]

This participation began with a CAN $10 million contribution from DND granting Canada Level 3 status in the program. Key rationales for Ottawa's decision to participate included the need to replace the CF-18, work with allies in devoting a new fighter jet, and potential opportunities for Canadian companies to participate in designing and producing the JSF if Canada decided to purchase this aircraft.[5]

Following the United States awarding Lockheed Martin the JSF contract in October 2001, DND signed a second MOU for the JSF's second phase involving system demonstration and development in February 2002. The government's Treasury Board approved CAN $171 million for this in December 2001 which DND provided directly to the JSF Program. A DND representative was assigned to the JSF program office in Washington and a further CAN $50 million was contributed to Canadian industries desirous of participating in JSF through extant programs from Industry Canada (Canada's Commerce Department) intended to support strategic research and development products. The year 2003 saw a DND technical, costing, and manufacturing review produce the first JSF program adjustment.[6]

Harper Government

Further significant and controversial developments with the JSF began with the January 23, 2006, election of Stephen Harper's Conservative government which remained in power until November 4, 2015. In June 2006, DND completed a preliminary options analysis of five candidate fighter aircraft and selected the JSF saying it best met Canadian Forces' requirements, had the longest life expectancy, and was the most affordable aircraft. A third-phase MOU was signed on December 12, 2006, covering production, sustainment, and follow-on development. Industry Canada signed industrial participation MOUs with US prime contractors Lockheed Martin, Pratt & Whitney, and GE Rolls-Royce, and the Treasury Board approved CAN $192 million in funding to 2013 for JSF's third phase. DND argued that this MOU offered the following benefits to Canada:

- Unprecedented access to data about next-generation fighter aircraft,
- Cost avoidance (not having to pay for research and development costs or fees associated with foreign military sales),
- Savings on long-term sustainment costs through collaborating with international partners,

- Military interoperability with allies and their equipment, and
- Potential royalties on F-35 sales to non-partner countries.

The following year saw a second JSF program adjustment due to program cost increases. Additionally, signing this MOU represented a financial commitment of $551 million to the JSF program for up to 40 years while mandating Canadian acceptance of US F-35 procurement rules.[7]

On May 12, 2008, the Harper Government released the *Canada First Defence Strategy*. This policy document, introduced by Harper and Minister of National Defence Peter Mackay (CPC—Central Nova, NS), called for replacing the CF-18 fleet with 65 JSF fighters beginning in 2017, stressing that these fighters would enable defending Canadian airspace sovereignty, remaining a strong and reliable North American Air Defence partner through North American Aerospace Defense Command (NORAD), and providing effective and modern air capability for international operations.[8]

The year 2008 also saw DND begin work on replacing the CF-18 by identifying 14 high-level mandatory capabilities and implementing an independent cost review of the JSF program. In 2009 DND sought the government's decision to purchase the F-35, but this process was put on hold due to continual cost increases and procedural oversights such as DND not giving Public Works and Government Services Canada (PWGSC) (the Canadian government procurement agency) a copy of the 2006 MOU until December 2009.[9]

Cost Overruns Controversy 2010

Controversy over the procurement procedures and costs of the JSF would erupt in 2010. On June 1, 2010, DND informed PWGSC that the F-35 is the only aircraft available for future Canadian aircraft requirements. On July 16, 2010, Mackay, Treasury Board Minister Tony Clement (CPC—Parry Sound-Muskoka, ON) and PWGSC Minister Rona Ambrose (CPC—Edmonton Spruce Grove, AB) announced that the F-35's CTOL version would be purchased as a single-source noncompetitive contract under a provision in *Government Contract Regulations* permitting such contracting. This announcement was made while Parliament was in recess and would ignite a firestorm of controversy when it resumed sitting in September 2010.[10]

DND estimated JSF's acquisition cost at $CAN 9 billion and Lt. General André Deschamps, then Canada's Chief of Air Staff and Commander of Air Command, justified the government's decision saying the JSF was the only aircraft meeting Canadian security requirements and the only fifth-generation fighter available to Canada due to its array of technical capabilities including stealth, secure communications, ability for pilots to operate the aircraft in no-light conditions, and to automatically share data and sensor information with friendly aircraft. Deschamps also argued:

> The acquisition itself will cost $9 billion. However, this represents the cost of 65 individual aircraft as well as contingency funding for currency escalation, plus program costs, integrated logistics support, weapons, infrastructure, simulation and so on—all of which will be intrinsic costs to any modern fighter acquisition. We estimate the cost per aircraft to be in the low-to-mid US $70 million range. We will be purchasing our aircraft—which is the most cost-effective variant of the *Lightning II*—between 2016 and 2022, which will be the peak point of production, … when costs are projected to be at their lowest. In fact, in 2016 dollars, the per aircraft cost of buying the F-35 is only slightly more than the per-aircraft cost paid for the CF-18 *Hornet* in the 1980s.[11]

When Parliament resumed sitting in September 2010, the House of Commons Standing Committee on National Defence met 11 times between then and December 2010 to scrutinize the proposed purchase. The Aerospace Industries Association of Canada (AIAC) supported the F-35, but union representatives expressed concern that Canadian firms would be vulnerable to Lockheed Martin and US political pressure which they believed would support US contractors over Canadian contractors.[12]

Opposition parties, including the Liberals and New Democratic Party (NDP), questioned this purchase and were particularly critical of the use of sole-source contracting. On September 20, 2010, then Liberal leader Michael Ignatieff (Etobicoke—Lakeshore, ON) argued that if the government was going to bid for $CAN 16 billion worth of aircraft, it should have a competitive bid to give regional economic business to all Canadian aerospace industries. Harper replied noting that in 2002 the Liberal Government spent $CAN 150 million to participate in the international JSF competition, that Canada needed to purchase the JSF to keep the Canadian Air Force from being grounded, and that the government did not play politics with the aerospace industry or the military.[13]

This controversy heated further up that day when Siobhan Cody (LIB—St. John's South-Mount Pearl) asked, "Why is the Conservative Government throwing the rule book, for fear and competition out of the window? Why would the government do it for Canada's largest military purchase, a $CAN 16-billion purchase, instead of trying to save taxpayers money?" Replying for the Government, PWGSC Minister Ambrose said:

> On the issue of a competition, there was an international competition. In fact, the Liberals were part of that competition, so they should know it very well. Holding another competition would risk the future of our aerospace industry because any delays, frankly, would be slamming the door shut on Canadian jobs and Canadian companies. I would ask the member opposite, why would the Liberals take such a risk?

Cody went on to ask Mackay why the government proceeded without a competition and who made what she called an arbitrary decision. Mackay said Cody's assertion was "patently false," that DND had not called for a competitive competition, and quoted Deschamps' 2010 *Canadian Military Journal* article to explain the government's purchasing rationale.[14]

2011 Parliamentary Budget Officer Report

Further demonstration of problems with Canada's JSF program was revealed with the March 10, 2011, release of a Parliamentary Budget Officer (PBO) report. This report was highly critical of JSF cost assessments provided by DND in 2010. It maintained that DND's projected acquisition, logistics, research, developing, testing, and evaluation cost estimates of $CAN 17.6 billion were incorrect and that the actual costs were $CAN 29.3 billion which contributed to a five-year delay and $CAN 21 billion cost overrun in the US JSF program. PBO also criticized the program for its lack of clarity including the absence of policy documents outlining specific program functions; that it is not clear how workshare commitments can be guaranteed with a "best value sourcing model"; that potential benefit for Canadian subcontractors will be reduced by order reductions or increased by order increases; and that it is not possible to determine the ability of Canadian industries to compete effectively for program contracts or subcontracts.[15]

The PBO report went on to announce that Canada would purchase its projected JSF allotments as indicated in Table 6.1:

Table 6.1 2011 Parliamentary Budget Office JSF purchase projections[16]

2016	1
2017	3
2018	9
2019	13
2020	13
2021	13
2022	13

In addition, this report also noted the exponential cost increases in manufacturing costs of jet fighters over the past six decades. These costs have risen from less than $CAN 1000 per kilogram in 1950 to $CAN 10,000 per kilogram in 2009 dollars. Additional data can be derived from the average weight of jet fighters increasing about 0.5% per year due to technological innovation and military operational requirements over this time period. This means that fighter aircraft costs have increased 4% in real terms since 1950 and doubling approximately every 18 years.[17]

Evaluating JSF cost by weight was criticized by Deputy Minister of Defence Robert Fonberg in a May 1, 2012, hearing before the Commons Standing Committee on Public Accounts Committee with Fonberg saying PBO used a top-down approach or parametric analysis which is not regarded as appropriate for a project in a conceptual developmental state. During this same hearing DND Chief Financial Officer Kevin Lindsey also noted that PBO used parametric modeling because the acquisition price had been significantly inflated above what DND understood to be the then-current cost from JSF's joint project office. Lindsey went on to maintain that if PBO used what DND regarded as JSF's acquisition price then PBO's estimates would have been nearly $12 billion less over the 30-year time frame.[18]

A March 23, 2011, PBO report noted that while DND used 20 years as the functional lifespan for JSF cost estimates, PBO used 30 years as the functional lifespan for their cost estimates due to DOD's Selected Acquisition Report forecasting a 30-year operational life for JSF. This PBO document also forecast that JSF's average unit cost acquisition would be $CAN 128 million **excluding** upgrades and overhaul as opposed to DND's estimate of $CAN 75 million **including** upgrades and overhaul. PBO also mentioned its inability to evaluate the robustness of DND cost estimates since DND did not provide it with methodology, assumption, uncertainties, and risks surrounding its figures.[19]

2011 Parliamentary No-Confidence Vote and Election

Controversy over JSF problems, opposition displeasure at other Harper Government policies including the budget, and the government's minority status in the House of Commons resulted in parliamentary no-confidence motion by a 156–145 vote on March 25, 2011, and an election was set for May 2. Mackay, in responding to Liberal opposition charges of governmental misconduct on JSF purchasing, retorted:

> Professional public servants have looked at the Parliamentary Budget Officer's numbers and they reject his methodology. The reality is that we will be buying these aircraft at the best price. They are the best aircraft. In fact, the only aircraft available. We will take no lessons from the member opposite and his party, which gutted the Canadian Forces during its time in office, which cancelled important helicopter programs and is prepared to do the same thing and put men and women in jeopardy with underfunded equipment.[20]

Despite losing this parliamentary vote of confidence, the Conservatives would have the last laugh winning the May 2, 2011, election and obtaining a majority government, with the New Democrats replacing the Liberals as the official opposition.[21]

2012 Auditor General Report

Problems with the JSF would continue bothering the Harper Government in its third term. On April 3, 2012, Canada's Auditor General (AG) released a report on the JSF containing additional scathing criticism though no evidence of criminal conduct according to later investigations by the House of Commons Committee on Public Accounts. AG report findings included:

- DND took appropriate steps managing Canadian JSF participation and engaged Industry Canada to successfully manage industrial participation while successfully achieving early contract opportunities for Canadian companies.
- The JSF decision-making process contained significant weaknesses with key steps being taken out of sequence and key decisions being made without required approvals or supporting documentation.

- PWGSC failed to carry out its governmental procurement authority role. Although not engaged by DND until late in the decision-making process, it endorsed the sole-source acquisition without required documentation and completed analyses.
- DND failed to provide complete information in a timely manner. Briefing materials prepared for decision makers did not explain the basis for and limitations of projections of industrial benefits to Canadian companies, and the risks of relying on projections to make decisions. These briefing materials also failed to inform key decision makers, including the Minister of Defence, of problems and risk relying on the F-35 to replace the CF-18.
- DND probably underestimated F-35 full LCCs The $CAN 25 billion acquisition and sustainment costs were initially set in 2008 without complete cost and other information which may not be available for several years. This may require DND to find alternative ways to cover potential additional costs and or seek other funding sources to cover these costs.[22]

Additional recommendations made in the AG report included DND needing to refine its estimates for complete costs related to F-35 full life cycle capability, providing complete estimated costs and supporting assumptions as soon as possible, and providing actual complete costs incurred through the entire life cycle of F-35 capacity.[23]

National Fighter Procurement Secretariat

In June 2012, the Government responded to the AG's report by establishing the National Fighter Procurement Secretariat (NFPS) within PWGSC to ensure the government stays on course with its JSF objectives. Canada remained a JSF program partner although acquisition funding was frozen. Besides establishing NFPS and freezing funding, the additional five points of a seven-point action plan consisting of the following steps include:

1. DND, through the Secretariat, will provide annual updates to Parliament, tabled within 60 days of receipt from the US JSF program office's annual cost forecasts.
2. DND continues evaluating options to sustain a Canadian Forces' fighter capability.

3. The Treasury Board Secretariat (TBS) will commission an independent review of DND acquisition and sustainment project assumptions and potential costs.
4. TBS will review F-35 acquisition and sustainment costs to ensure full compliance with procurement policies before project approval.
5. Industry Canada will work with NFPS to continue identifying opportunities for Canadian industry to participate, other potential benefits for Canada, and update Parliament.[24]

NFPS operations began on June 13, 2012, and on September 7, 2012, the Government announced that accounting firm KPMG had been awarded a competitive contract to review acquisition and sustainment process assumptions and potential costs for replacing the CF-18; developing a framework to assess expected JSF operational LCCs and report to Parliament. In November 2012, the House of Commons Standing Committee on Public Accounts issued a report recommending that DND provide various JSF cost acquisition estimates to them and that Industry Canada provide a range of estimated industrial companies participating in JSF by February 7, 2013.[25]

On November 27, 2012, KPMG released an independent report for TBS on the JSF's life cycle cost covering 42 years from 2010 to 2052. Report findings estimated the cost of purchasing the JSF had risen to $CAN 45.802 billion including purchasing replacement aircraft due to attrition. This report also noted that the completeness of certain cost elements could not be fully verified because of access restrictions to the JSF's Statement of Operational Requirement and projected aircraft lifespan of 30 years after delivery. Report recommendations included:

1. DND formalize and document the life cycle costing plan according to Framework Guidance.
2. DND clarify documented assumptions concerning yearly flying rate and fleet size and regularly review Life Cycle Cost estimates.
3. DND continually review and update the Cost Breakdown Structure and the Ground Rules and Assumption document to ensure the Cost Breakdown Structure and Life Cycle Cost Estimate include all capability requirements.
4. DND refine and simplify the financial model to enhance its flexibility, traceability, and sensitivity analysis ease.

5. The Canadian Government investigates mechanisms to more effectively manage program foreign exchange risks.
6. DND normalize and adjust all CF-18 operating costs to enhance F-35 operating cost estimates.
7. DND conduct further analysis and communicate key assumptions concerning effective aircraft life use after 30 years.
8. DND allocate an appropriate contingency level to acquisition cost to reflect remaining acquisition risks and desired cost certainty level.[26]

This report and its increased cost findings prompted the Harper Government to delay its participation in JSF in a decision described by Ambrose as, "We have hit the reset button and are taking the time to do a complete assessment of all available aircraft."[27]

2013 Cost Reports

While this reset delayed Canadian purchasing of the JSF, it did not mean Ottawa's involvement in this program has been suspended. The NFPS continues its work and a June 7, 2013, report showed the JSF's cost estimate had dropped to $CAN 45.691 billion from the 2012 estimate of $CAN 45.802 billion. This report also noted that software remains a challenging program technical risk which the US F-35 Joint Program Office is working to manage. Additional report contents include that purchasing JSF will require new construction and upgrades to existing infrastructure at Royal Canadian Air Force (RCAF) bases in Bagotville, QC; and Cold Lake, AB; along with additional operational locations at Inuvik and Yellowknife, NWT; Iqaluit and Rankin Inlet, NU; and Goose Bay, NFLD.[28]

An August 5, 2013, independent cost review by Raymond Chabot Grant Thornton determined that Canadian JSF Life Cost Cycle planning was a well-documented assessment explaining work completed, summarizing cost estimates, and including key assumptions and cost details. It went on to mention that all cost boundaries had been developed considering their purpose and were clearly defined; that model documentation is well developed for a majority of costing elements except for a configuration management plan; and that there needs to be a better alignment of fuel cost estimates directly to forecasted flying hours.[29]

On November 24, 2013, Sanson & Associates released a report reviewing the CF-18 acquisition replacement process. Its determinations included that the parallel tracks for JSF and CF-18 replacement were misaligned; that DND, TBS, and PWGSC need to ensure that MOUs are signed consistent with production planning and acquisition cycles; that MOUs are treated like contracts and follow appropriate contractual processes; and that PWGSC always be involved in developing and signing production related MOUs. Sanson also recommended that DND ensure project management capability is assigned to the Project Sponsor project office as early as the identification phase and is appropriately supported until the project reaches definition phase; that operational requirements statements be sufficiently supported for future high-value complex projects; and that one guidance document should be prepared detailing accountability, responsibilities, and requirements for sponsoring departments to inform stakeholders in the procurement process.[30]

2014 Cost Report

The 2014 JSF cost review found that program costs have risen to $CAN 45.832 billion which DND and Raymond Chabot Grant Thornton attributed to actual and projected differences between the US and Canadian dollars, other economic factors affecting cost estimates received from the US F-35 Joint Program Office on August 28, 2014, and the assumption that delivery of F-35 to Canada would occur in 2020 due to the CF-18 fleet's lifespan being extended to 2025. These costs also include operational and support costs such as aviation fuel, training weapons and ammunition usage, providing base-level support infrastructure, and material costs including administration, firefighting, maintenance, and medical. Such costs do not include disposal costs once the F-35 lifespan ends. In addition, a change of 1 ¢ in the Canadian/US dollar exchange rate impacts sustainment cost estimates by $CAN 113 million.[31]

Canadian Defense Industry and JSF

As is true with other countries, JSF contracts have been scattered across Canada strengthening this program's political support despite cost problems, with this support at least partially encompassing the spectrum of Canadian political parties. Table 6.2 lists a sampling of companies involved in JSF production along with their geographic locations.

Table 6.2 Canadian JSF contractors[32]

Advanced Integration Company—Langley, BC	Assembly line tooling systems
Alcoa Howmet—Langle, QC; Georgetown, OH	Inlet and duct castings
Asco—Delta, BC	Large titanium bulkheads and other machine parts
Avcorp Industries—Delta, BC	Carrier variant outboard wings
Centra Industries—Cambridge, ON	Forward and center fuselage machined components
CMC Electronics—Saint Laurent, QC	Transceivers
Composites Atlantic—Lunenburg, NS	Composite structures
GasTOPS—Ottawa, ON; Dartmouth, NS; Mt. Pearl, NFL	Oil debris monitors and sensors
Héroux-Devtek—Longueuil, QC; St. Hubert, QC; Laval, QC; Kitchener, ON; Scarborough, ON	Landing gear door locks
Honeywell—Mississauga, ON	Power thermal management system controllers
Magellan-Bristol—Mississauga, ON	Conventional take-off and landing variant horizontal tails
Magellan-Chicopee—Kitchener, ON	Machined components
MDS Aero Support Corporation—Ottawa, ON; Thompson, MB	Test equipment for F-135 engine vertical life system.
NGRAIN—Vancouver, BC	3D damage assessment software
Pratt & Whitney Canada—Longueil, QC	F-135 engine components
Virtek—Waterloo, ON	Laser templating technology for 3D composite ply alignment

During June/July 2012 this represented 72 Canadian companies involved in JSF contracts worth $CAN 438 million with design and development contracts worth $CAN 232 million and production and sustainment contracts worth $CAN 206 million. These companies represent the Canadian aerospace industry's contribution of $CAN 25.6 billion to Canadian GDP from a workforce of 161,966. Nearly 80% of this aerospace manufacturing output is exported with Canadian aerospace exports in 2011 broken down by the following categories producing a $CAN 4.6 billion aerospace trade surplus for this year (Table 6.3).

Canadian contractual participation in JSF had expanded to $CAN 637 million as of Fall 2014 with the total identified potential opportunities for Canadian companies being $10.808 billion as of Summer 2014.[34]

Table 6.3 2011 Canadian aerospace export percentages[33]

Aircraft and rotorcraft	48%
Engines and related parts	27%
Avionics	5%
Flight simulators	5%
Other parts	15%

Additional Background

These controversies and delays delayed more definitive Canadian decision on purchasing the JSF will not come until after the October 19, 2015, parliamentary election. If the Conservative Harper Government was returned to power, it was/is more likely Canada will purchase the JSF. However, if there was a Liberal Government headed by Justin Trudeau (Papineau) or a coalition government involving these two parties a definitive decision to purchase the JSF is less likely and may be rejected in favor of another fighter option based on a October 29, 2013, parliamentary speech by Liberal Party defense critic (Joyce Murray—Vancouver Quadra, BC) and the New Democratic Party's 2013 policy document.[35]

Despite the protracted and serious budget problems Canada has experienced with the JSF, it cannot ignore the international and geographic security environment it faces, particularly in the Arctic. A 2013 intelligence assessment by Canada's Chief of Defence Intelligence cautions:

> Foreign military weapons that could threaten Canada up to 2030 will grow in direct correlation to technological improvements made by potential adversaries, both state and non-state. Future threat aircraft will likely have the ability to fly further, faster and higher than current threats as well as have an increased payload potential. Missiles, capable of high speeds and capable of being launched from land, air and maritime platforms, could also present threats to Canada. Additionally, naval aircraft carriers will likely become more prevalent as emerging states envisage their use to project power.[36]

This analysis also noted the emergence of new fighter aircraft capable of operating in network-centric combat environments and featuring extremely low, all-aspect, multi-spectral signatures using advanced materials and shaping techniques. These designs also include infrared search and track sensors for air-to-air combat and air-to-ground weapons delivery. Additionally, such sensors, incorporating advanced avionics, glass cockpits, helmet-mounted sights, and improved secure, jamming resistant lowprobability of intercept data links, are well integrated and provide multi-platform, multi-sensor data fusion to vastly increase situational awareness and lessen pilot workloads.[37]

Canada also is confronting the problem of increasing aggressive aerial behavior by Russian military fighter aircraft including incursions into Canadian airspace. On March 23, 2009, MP Laurie Hawn (CPC—Edmonton Centre, AB) told the House of Commons Standing Committee on National Defence that during 2007–2008 there had been 30 penetrations of US and Canadian air defense identification zones, with 28 of these been intercepted by NORAD and 8 of these interceptions being conducted by Canadians. In only three of these cases was advance notification of these flights given.[38]

On April 29, 2014, MP James Bezan (CPC—Selkirk-Interlake, MB) noted that NORAD officials say that Canadian airspace is regularly tested by Russian military aircraft in the Arctic, the Pacific, and Atlantic coasts, and Canadian airspace.[39] Canadian Major General D.L.R. Wheeler, the Commander of the RCAF's 1 Air Division, thought the Russian air threat to Canada very low, but also added:

> They do fly up into our northern area. They come into the Canadian air defence identification zone. They don't actually come into Canadian sovereign territory, but they will get as close as 40 to 50 miles off our coast. We're very cognizant of that. We certainly intend to protect our sovereignty and therefore we do scramble fighters, or locate them at some of our forward operating locations, to make sure the Russians know we're there and are willing to protect our sovereignty.[40]

Specific examples of Russian airspace incursions into Canada included multiple late May/early June 2014 instances of Russian aircraft carrying out incursions into US and Canadian Arctic Air Defense Identification Zones (ADIZ). In early September 2014, Russian strategic bombers in the Labrador Sea practiced cruise missile strikes on the United States. Although these aircraft stayed out of Canada's ADIZ, this occurred while a NATO summit was occurring, and if these missiles had been launched, Ottawa, New York, Chicago, Washington, DC, and the Norfolk Naval Base would have been within their range. The frigate *HMCS Toronto* was buzzed by Russian aircraft in the Black Sea on September 7, 2014, with the *Toronto* locking its radar on the Russian plane but not taking further action at a time when major Russian naval combat training was ongoing near Sevastopol. On September 18, 2014, Russian jets were intercepted by Canadian fighters in the Beaufort Sea Canadian ADIZ while Ukrainian President Petro Poroshenko was visiting Ottawa and Washington (Fig. 6.1).[41]

Fig. 6.1 Map of Russian Military Bases and SAR Centers in the Artic. Source: Conley and Rohloff, CSIS

Trudeau Government

The October 19, 2015, parliamentary election saw the defeat of Harper's Conservative Government and the election of a Liberal Government headed by Prime Minister Justin Trudeau.[42] Besides Trudeau, a key player in this government's emerging defense strategy was Harjit S. Sajjan (LIB—Vancouver South, BC). At the beginning of his tenure, Sajjan received a ministerial mandate letter from Trudeau outlining governmental defense policy objectives. One of these objectives was working with the Minister of Public Services and Procurement to launch an open competition to replace the aging CF-18 fighter aircraft averaging over 30 years whose fleet size has declined from 138 to 77 with something other than the JSF while also focusing on surveillance and control of Canadian approaches such as the Arctic regions.[43]

During the 2015 election campaign Trudeau claimed it no longer made sense for Ottawa to purchase the JSF citing its costs and development problems while vowing to buy less expensive aircraft and invest saved money into the Royal Canadian Navy. However, on February 24, 2016, DND announced that Canada planned to make its annual US $32 million payment to continue participation in the JSF allowing Canada to purchase the JSF at a discount and for Canadian companies to continue bidding on JSF contracts. Sajjan said: "We can't just make a very quick decision on something like this. We want to make a responsible decision as we move forward. We have to go through the proper requirements. Once we go through a proper process, decisions will be made at that." Senator Daniel Lang (CPC—Yukon), the Chair of the Senate's National Security and Defence Committee, responded by saying, "Why would anybody spend millions of dollars to stay in a program they're not going to participate in?"[44]

A key reason for the Liberal Government's decision to remain partially involved with the JSF, despite its desire to find another replacement for the CF-18, was the CAN $300 million contributed to the JSF program since its inception and Canadian firms receiving CAN $750 million in contracts according to a March 2016 report by the Canadian Senate's Finance Committee. This document also noted that if Canada decided to withdraw from the JSF that there would be no specific cancelation fee but that there would negotiations with remaining participants on withdrawal costs. During the February 25, 2016, House of Commons debate Sajjan reiterated to skeptical parliamentarians that participating in JSF brought benefits to Canadian companies and did not commit Ottawa to buy the planes.[45]

A May 16, 2016, House of Commons debate on potential CF-18 program replacement saw Erin O'Toole (CPC—Durham, ON) ask Sajjan which Canadian Government began the CF-18 replacement procurement process. Sajjan responded that it began under the Harper Government, but O'Toole corrected him saying it began under the Chretien Government. O'Toole also noted that changing procurement processes midstream delays equipment receipt for a generation. He also asked Sajjan if Canada should choose a fighter not just for the present but for 30 years into the future and Sajjan replied that there needed to be procurement adaptability and that there were problems with the JSF which needed to be addressed.[46]

June 1, 2016, saw Industry Canada issue guidance about the Strategic Aerospace and Defence Initiative (SADI) program to assist Canadian aerospace R&D initiatives and collaboration. SADI stressed that for JSF projects repayment may be based upon actual program-related revenues; that projects seeking funding under JSF terms must demonstrate a direct link to the JSF supply chain; and that Technical Assistance Agreements, Non-Disclosure Agreements, and Letters of Interest represent documents acceptable for establishing a link to this program.[47]

Partisan feuding between the Conservatives and Liberals over the CF-18 replacement continued on June 9, 2016, when Conservative defense critic Bezan charged the Liberals with not investing any money into the CF-18 which he contended was creating a capability gap and endangering fighter pilots' lives. Sajjan responded that program mismanagement left the government with no choice but extending the CF-18's life to 2025. Pierre Paul-Hus (CPC—Charlesbourg-Haute-Saint Charles, QC) responded saying,

> All the reports confirm that the government has made up its mind to buy the Super Hornet. The only thing left to do is to find some red lipstick to put on the pig to make this thing presentable. The minister says that no decision has been made and that information is being gathered in order to make the best choice for the Canadian Forces. If that is the case, can the minister tell us whom he is in contact with in the industry, other than Boeing, to replace our CF-18s?

Sajjan said the government was still gathering information and that no decision had been made, to which Hus retorted that as time goes by the decision to buy the Super Hornet does not make sense, that there be an open and transparent CF-18 replacement procurement process, and that the Canadian Government should not emphasize creating US jobs.[48]

This wrangling over the JSF and possible replacements for the CF-18 occurred during a December 1, 2016, House of Commons Standing Committee on National Defence meeting when Bezan asked Sajjan if the CAN $3 million DND budget request for defense procurement was going to be used to replace the CF-18 fleet and if sole sourcing of the Super Hornets was responsible spending. Context for Bezan's questioning stemmed from Canada announcing on November 22, 2016, that it was acquiring 18 new F-18 Super Hornet aircraft and Sajjan replied that DND was committed to replacing the entire air fleet with open competition that a forthcoming 2017 defense policy document, whose public consultation process began in April 2016, would contain specific details. Bezan then asked how much the Super Hornets would cost and Sajjan responded that costs would be determined once discussions began with Boeing.[49]

On December 12, 2016, Trudeau announced that Lockheed Martin could still participate in a competition for the CF-18's replacement, but in November 2016 said that it plans to buy 18 Boeing Super Hornets while acknowledging that the competition for the CF-18's replacement could take five years. As of late February 2017, DND had not released a defense policy report and it remains uncertain whether Canada will eventually purchase the JSF, the Super Hornet, or some other emerging jet fighter. Frustration over Canada's convoluted defense procurement process remains a perpetual factor in Canadian defense spending to the consternation of Canada and its international partners.[50]

Strong Secure Engaged: Canada's Defence Policy was released by the Trudeau Government on June 7, 2017. It called for Canada to procure a fighter capacity of 88 jets to replace the aging CF-18 fleet while also calling on exploration of the possibility of acquiring an interim aircraft to supplement the CF-18.[51] On December 12, 2017, Canada announced that it would purchase supplemental F-18 aircraft from Australia and that these planes would be modified to fit into current RCAF fleet configurations.[52] The Canadian Government's procurement website already includes a number of solicitations for possible interest in the CF-18 replacement with the most recent specifications being posted on December 12, 2017, with February 9, 2018, being the requested submission deadline.[53]

Political contentiousness over the CF-18 replacement project, whether it is the JSF over some other plane, remains a hallmark characteristic of Canadian defense policy debate. On June 19, 2017, an exasperated Bezan exclaimed:

The Liberals' mismanagement of the fighter jet replacement has gone from a national scandal to an international embarrassment.

Over the weekend, officials were instructed to meet with aerospace companies in Paris, then they were told to cancel those meetings, and then they were told to reschedule them. The Minister of National Defence has made a complete mess of this file. Is there anyone on the Liberal benches, anyone at all, who can fix this comedy of errors and actually hold an open competition to replace our aging fighter jets now?[54]

Bezan continued his assault on September 28 proclaiming:

The Liberals' fighter jet replacement fiasco has gone from bad to worse. The Prime Minister has stated that Boeing is no longer a trusted partner and has threatened to cancel all future projects with Boeing. This includes the Liberals' asinine interim purchase of 18 Super Hornets, which has been mocked by the entire defence community. Will the Liberal government stop playing partisan political games with our troops and immediately launch an open and transparent competition?[55]

Jean Rioux (LIB—Saint Jean, QC), the Parliamentary Secretary to the Minister of Defence, replied that the government was committed to purchasing 88 jets to replace the aging CF-18 fleet and that Canada was determined to keep its NATO and NORAD commitments along with protecting national security. He also maintained on November 6, 2017, that Canada was committed to maintain a transparent competition which would benefit Canadian industry.[56]

On November 21, 2017, Bezan incisively criticized the quality of the Australian F-18s Canada intended to acquire with the following indictment:

It is interesting to note that the Australian auditor general did a report on the legacy F-18 Hornets. Right now Australia plans to roll down those planes, and withdraw them from service in 2020, because they are buying new F-35s. If anyone is confused, the Australians had also bought 24 new Super Hornets. In 2010, Australia bought brand new Super Hornets, the F-18s, and are going to use them until 2025. Our fighter jets, our legacy fleet of CF-18s, are only tasked to fly until 2025. Time is crunching down on us here. We are now looking at less than eight years—it is seven and a half years—to replace our entire fleet. Buying those Super Hornets is not possible. The problem is that these legacy Hornets coming from Australia, that the auditor general has said would be retired in 2020, three years from now,

> have significant aged-aircraft issues, which are resulting in maintenance durations and costs becoming less predictable. All but nine of the aircraft have experienced structural fatigue above that expected for the airframe hours that have already been flown. That fatigue count is higher than that of even the legacy Hornets here in Canada and those in the U.S. Navy.[57]

Trudeau, responding to questioning from Conservative Leader Andrew Scheer (Regina—Qu'Appelle, SK) on the problems and protracted delays involved with acquiring a CF-18 replacement, said the Conservative Government was unable to deliver the equipment Canadian forces needed and that inquiring interim jets was the only choice his government had.[58] On February 27, 2018, the Canadian Government announced that Airbus, Boeing, Dassault, Lockheed Martin, and Saab were the five firms under consideration for replacing the CF-18 fighter, meaning Canada could still end up purchasing the JSF. Formal engagement with eligible suppliers is occurring between Spring 2018 and Spring 2019, a contract is expected to be rewarded in 2021–2022, and the first replacement aircraft are supposed to be delivered in 2025.[59]

Conclusion

Canada's experience with financing and building the JSF has been a troubling and contentious one. However, given the increasing aggressiveness of Russian military aircraft against Canadian airspace and Canadian military targets, geopolitical and domestic aerospace industry requirements make it likely that Canada will make some kind of tangible commitment to purchasing the JSF or a similar fifth-generation fighter given this emerging and deteriorating international security environment regardless of the political makeup of Canada's Government. This will be done in order to maintain Canadian military interoperability with the United States and other NATO allies and consistency with 2014 Canadian aerospace doctrine stressing the need for Ottawa to have multirole platforms capable of organic escort including the JSF or the Eurofighter Typhoon regardless of what opposition might occur within some spheres of domestic Canadian political debate.[60]

Notes

1. See J.L. Granatstein, *Whose War is It?: How Canada Can Survive in the Post 9/11 World* (Toronto: HarperCollins, 2007); Government of Canada, *Canada's Northern Strategy: Our North, Our Heritage, Our Future* (Ottawa: Public Works & Government Services Canada, 2008); http://www.northernstrategy.gc.ca/cns/cns.pdf; accessed March 19, 2017; David Curtis Wright, *The Dragon Eyes the Top of the World: Arctic Policy Debate and Discussion in China* (Newport, RI: China Maritime Studies Institute, U.S. Naval War College, 2011): http://digital-commons.usnwc.edu/cmsi-red-books/2/; accessed March 19, 2017; Kristofer Bergh, *The Arctic Policies of Canada and the United States: Domestic Motives and International Context*, *SIPRI Insights on Peace and Security* (2012/1: July 2012): https://www.sipri.org/sites/default/files/files/insight/SIPRIInsight1201.pdf; accessed June 6, 2018; General Tom Lawson, *The State of Canadian Armed Forces and Its Priorities* (Waterloo, ON: Center for International Governance Innovation, February 13, 2014): Webcast Accessible at https://www.cigionline.org/events/state-canadian-armed-forces-and-its-priorities; accessed February 23, 2017; and Stockholm International Peace Research Institute, *Military Expenditure Database, Military Expenditure of 2013 NATO Member States in Constant (2011) US$m* (Stockholm: SIPRI, 2018): http://www.sipri.org/research/armaments/milex/; accessed June 6, 2018; and Statistics Canada, *Table 1 Merchandise trade: Canada's Top 10 Principal Trading Partners – Seasonally Adjusted, Current Dollars* (Ottawa: Statistics Canada, 2018): 1–2; https://www150.statcan.gc.ca/n1/daily-quotidien/180606/t001a-eng.htm; accessed June 6, 2018; accessed February 23, 2017.
2. J.D. McKillip and R.W.H. McKillip, "Point F35S and the Canadian 'Military-Technical Condition,'" *The Royal Canadian Air Force Journal*, 3 (3) (Summer 2014): 56; http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss3-12-f35s-and-the-canadian-military-technical-condition.pdf; accessed March 23, 2017.
3. Martin Auger, *The Evolution of Defence Procurement in Canada* (Ottawa: Library of Parliament, 2016); http://www.lop.parl.gc.ca/Content/LOP/ResearchPublications/2016-09-e.pdf; accessed February 23, 2017.
4. See Kim Richard Nossal, "Late Learners: Canada, the F-35, and Lessons from the New Fighter Aircraft Program," *International Journal*, 68 (1) (Winter2012–13):167;https://doi.org/10.1177/002070201306800111; and Auditor General of Canada, *Report of the Auditor General of Canada to the House of Commons: Chapter 2: Replacing Canada's Fighter Jets* (Ottawa: Auditor General of Canada, 2012): 1, 5; http://www.oag-bvg.gc.ca/inter-

net/English/parl_oag_201204_02_e_36466.html; accessed February 23, 2017.

5. See Ibid., 10; and Atushi Tago and Srdjan Vucetic, "The 'Only Choice': Canadian and Japanese F-35 Decisions Compared," *International Journal*, 68 (1) (Winter 2012–13): 133; https://doi.org/10.1177/002070201306800109.
6. Ibid., 10, 12.
7. Ibid., 11–12, 17; and "Tories Freeze F-35 Funds and Open Door to Alternatives in Wake of Scathing AG Report," *National Post* (April 3, 2012): 1–4; http://news.nationalpost.com/news/canada/tories-freeze-f-35-funds-and-open-door-to-alternatives-in-wake-of-scathing-ag-report; accessed February 23, 2017.
8. Canada National Defence, *Canada First Defence Strategy* (Ottawa: DND, 2008): 4, 17; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/CFDS-SDCD-eng.pdf; accessed March 25, 2017.
9. *Chapter 2: Replacing Canada's Fighter Jets*, 12, 18–19.
10. See *F-35: The Politics of Procurement* (Ottawa: Canadian Public Affairs Channel, 2011): 3:17–4:30; https://www.youtube.com/watch?v=gdrDn9uXh48; accessed March 25, 2017; and Canada Department of Justice, *Consolidation: Government Contracts Regulations SOR/87-402* (Ottawa: Department of Justice, 2018): 6; http://laws-lois.justice.gc.ca/PDF/SOR-87-402.pdf; accessed June 6, 2018.
11. André Deschamps, "Meet the F-35 Lightning II-Canada's Next Fighter," *Canadian Military Journal*, 11 (1) (Winter 2010): 49–52; http://www.journal.forces.gc.ca/vo11/no1/doc/10-deschamps-eng.pdf; accessed March 26, 2017.
12. Tago and Vucetic, 135.
13. Canada, Parliament, House of Commons, *Debates*, 145 (66) (September 20, 2010): 4096; http://www.ourcommons.ca/Content/House/403/Debates/066/HAN066-E.PDF#page=32; accessed March 23, 2017; video at Canada, Parliament, Library of Parliament, *Parlvu* http://parlvu.parl.gc.ca/Embed/en/i/3267388/?ml=en&vt=watch; Accessed March 23, 2017.
14. Ibid., 4098–4099; and video at *Parlvu*, http://parlvu.parl.gc.ca/Embed/en/i/3267555/?ml=en&vt=watch; accessed February 23, 2017. These committee hearings were held on September 15, October 5, 7, 19, 28, November 4, 16, 25, and December 2, 7, and 9, 2010 according to Canada, Parliament, House of Commons, Standing Committee on National Defence, *Next Generation of Fighter Aircraft* (Ottawa: Standing Committee on National Defence, 2010); http://www.parl.gc.ca/CommitteeBusiness/CommitteeMeetings.aspx?Cmte=NDDN&Language=E&Mode=1&Parl=40&Ses=3; accessed March 26, 2017.

15. Canada, Parliamentary Budget Officer, *An Estimate of the Fiscal Impact of Canada's Proposed Acquisition of the F-35 Lightning II Joint Strike Fighter* (Ottawa: Parliamentary Budget Officer, 2011): 10, 24; http://www.pbo-dpb.gc.ca/files/files/Publications/F-35_Cost_Estimate_EN.pdf; accessed March 26, 2017.
16. Ibid., 25.
17. Ibid., 8.
18. Canada, Parliament, House of Commons, Standing Committee on Public Accounts, *Evidence: Tuesday, May 1, 2012* (Ottawa: Standing Committee on Public Accounts, 2012): 6, 18; http://www.ourcommons.ca/DocumentViewer/en/41-1/PACP/meeting-41/evidence; accessed March 26, 2017.
19. *Comparing PBO and DND Cost Estimates on Canada's Proposed Acquisition of the F-35 Joint Strike Fighter: Some Preliminary Questions and Answers on Key Issues* (Ottawa: Parliamentary Budget Officer, 2011): 1–2; http://www.pbo-dpb.gc.ca/files/files/Publications/F35_QA_EN.pdf; accessed March 26, 2017.
20. See Canada, Parliament, House of Commons, *Debates*, 145 (149) (March 25, 2011): 9257; 9284–9285 http://www.parl.gc.ca/content/hoc/House/403/Debates/149/HAN149-E.PDF; accessed March 26, 2017; and *Parlvu*, http://parlvu.parl.gc.ca/Embed/en/i/3827680/?ml=en&vt=watch; accessed February 23, 2017.
21. Elections Canada, *Report of the Chief Electoral Officer of Canada on the 41st General Election of May 2, 2011* (Ottawa: Elections Canada, 2011): 42; http://www.elections.ca/res/rep/off/sta_2011/stat_report2011_e.pdf; accessed March 26, 2017.
22. See Tago and Vucetic, 137–138, and Office of the Auditor General of Canada, *Report of the Auditor General of Canada to the House of Commons: Chapter 2: Replacing Canada's Fighter Jets* (Ottawa: Auditor General of Canada, 2012): 2–3; http://www.oag-bvg.gc.ca/internet/English/parl_oag_201204_02_e_36466.html; accessed June 6, 2018.
23. Ibid., 30.
24. Canadian Forces, *Government of Canada Announces Comprehensive Response to Chapter 2 of the Spring 2012 Report of the Auditor General of Canada* (Ottawa: DND, April 3, 2012): 1; http://www.forces.gc.ca/en/news/article.page?doc=government-of-canada-announces-comprehensive-response-to-chapter-2-of-the-2012-spring-report-of-the-auditor-general-of-canada/hir3oy82; accessed February 23, 2017.
25. Canada, Parliament, House of Commons, Standing Committee on Public Accounts, *Chapter 2, Replacing Canada's Fighter Jets, of the Spring 2012 Report of the Auditor General of Canada* (Ottawa: House of Commons Standing Committee on Public Accounts, 2012): 3, 9–10, 14, 16, 18–20;

http://www.ourcommons.ca/Content/Committee/411/PACP/Evidence/EV5534278/PACPEV41-E.PDF; accessed March 26, 2017.

26. See KPMG, *Next Generation Fighter Capability: Independent Review of Life Cycle Cost* (Ottawa: KPMG LLP, 2012): 2, 4, 14, 27; http://www.tbs-sct.gc.ca/reports-rapports/ngfc-cng/irlc-eiccv/irlc-eiccv-eng.pdf; accessed March 27, 2017; and Department of National Defence, *Next Generation Fighter Capability Annual Update* (Ottawa: DND, 2012): 27; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/ngfc-annual-update-2012.pdf; accessed March 27, 2017.
27. Carola Hoyos, "Canada Puts JSF On Ice," *Financial Times* (December 13, 2012); https://www.ft.com/content/820a1384-453a-11e2-858f-00144feabdc0; accessed February 23, 2017.
28. Canada, Department of National Defence, *Next Generation Fighter Capability Annual Update* (Ottawa: Department of National Defence, 2013): ii–iii, 12, 18; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/ngfc-annual-update-2013.pdf; accessed March 27, 2017.
29. Raymond Chabot Grant Thornton, Public Works and Government Services Canada, *Independent Review: 2013 Department of National Defence Annual Update on Next Generation Fighter Capability Life Cycle Costs* (Ottawa: Public Works and Government Services Canada, 2013): 10–11; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/ngfc-independent-review-2013.pdf; accessed March 27, 2017.
30. Sanson and Associates, *Review of the Acquisition Process to Replace Canada's* CF-*18 Fleet* (Ottawa: Public Works and Government Services Canada, 2013): 12–18; https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/documents/flotte-fleet-18-eng.pdf; accessed February 23, 2017.
31. Canada Department of National Defence, *Next Generation Fighter Capability Annual Update 2014* (Ottawa: Department of National Defence, 2014): ii–iii, 12, 21–22, 35; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/next-gen-fighter/2014/next-generation-fighter-capability-annual-update-2014-english.pdf; accessed March 27, 2017.
32. Industry Canada, *Canadian Industrial Participation in The F-35 Joint Strike Fighter Program* (Ottawa: Industry Canada, 2012): 14; https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Report_to_Parliament.pdf/$file/Report_to_Parliament.pdf; accessed March 19, 2017.
33. Ibid., 4, 9–10.
34. Ibid., *Canadian Industrial Participation in the F-35 Joint Strike Fighter Program* (Ottawa: Industry Canada, 2014): 5–6; https://www.ic.gc.ca/

eic/site/ad-ad.nsf/vwapj/Fall_2014_Report_Parliament.pdf/$file/Fall_2014_Report_Parliament.pdf; accessed March 20, 2017.

35. See Canada, Parliament, *House of Commons Debates*, 147 (10) (October 29, 2013): 519; http://www.parl.gc.ca/content/hoc/House/412/Debates/010/HAN010-E.PDF; accessed March 30, 2017; *Parlvu*, http://parlvu.parl.gc.ca/Embed/en/i/8111262/?ml=en&vt=watch; accessed February 23, 2017; New Democratic Party, *NDP Policy* (Ottawa: New Democratic Party, 2013): 19; https://charrois.files.wordpress.com/2015/02/ndp-policy-book.pdf; accessed March 30, 2017.
36. Canada, Department of National Defence, *Intelligence Assessment: Threat Capability Assessment for Canada's Fighter Aircraft Capability* (Ottawa: Department of National Defence, 2013): 3; http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2006%20Task%201%20(En)%20final.pdf; accessed March 30, 2017.
37. Ibid., 6.
38. Canada, Parliament, House of Commons Standing Committee on National Defence, *Evidence: Monday, March 23, 2009* (Ottawa: Standing Committee on National Defence, 2009): 5; http://www.ourcommons.ca/Content/Committee/402/NDDN/Evidence/EV3760417/NDDNEV08-E.PDF; accessed March 30, 2017.
39. Ibid., *Defence of North America: Evidence: Tuesday, April 29, 2014*, 11; http://www.ourcommons.ca/Content/Committee/412/NDDN/Evidence/EV6548239/NDDNEV21-E.PDF; accessed March 30, 2017.
40. Ibid., *Defence of North America: Evidence: Monday, February 16, 2015*, 4; http://www.ourcommons.ca/Content/Committee/412/NDDN/Evidence/EV7835212/NDDNEV46-E.PDF; accessed March 30, 2017.
41. Thomas Frear, Łukasz Kulesa, and Ian Kearns, *Dangerous Brinkmanship: Close Military Encounters Between Russia and the West in 2014* (London: European Leadership Network, 2014): 5, 7, 17; http://www.european-leadershipnetwork.org/medialibrary/2014/11/09/6375e3da/Dangerous%20Brinkmanship.pdf; accessed March 30, 2017.
42. Canada, Parliament, *History of Federal Ridings Since 1867: General Elections 42-2015/10/19;* http://www.lop.parl.gc.ca/About/Parliament/FederalRidingsHistory/hfer.asp?Language=E&Search=G; accessed February 23, 2017.
43. See Prime Minister of Canada, *Minister of National Defence Mandate Letter* (Ottawa: Prime Minister of Canada, 2015): 1; https://www.pm.gc.ca/eng/minister-national-defence-mandate-letter; accessed February 24, 2017; and Canada, Department of National Defence, *Future Fighter Capability Project* (Ottawa: Department of National Defence, 2018): 1; http://www.forces.gc.ca/en/business-equipment/future-fighter-capability.page; accessed June 6, 2018.

44. Steven Chase, “Canada to Stay in Program of F-35 Jet Buyers Despite Pledge to Withdraw,” *Globe and Mail* (February 24, 2016): 1–2; http://www.theglobeandmail.com/news/politics/canada-to-stay-in-program-of-f-35-jet-buyers-despite-pledge-to-withdraw/article28897002/; accessed February 24, 2017.
45. See Canada, Parliament, Standing Senate Committee on National Finance, *First Interim Report on the Main Estimates 2016–17: Fourth Report* (Ottawa: Standing Senate Committee on National Finance, 2016): 11; https://sencanada.ca/content/sen/committee/421/NFFN/Reports/NFFN-FourthReport-MainEstimatesFirstInterim_e.pdf; accessed February 24, 2017; and *House of Commons Debates*, 148 (25) (February 25, 2016): 1397–1398; http://www.ourcommons.ca/Content/House/421/Debates/025/HAN025-E.PDF; accessed February 24, 2017. Video at *Parlvu* http://parlvu.parl.gc.ca/Embed/en/i/8814970/?ml=en&vt=watch; accessed February 24, 2017.
46. Ibid., 148 (56) (May 26, 2016): 3441; http://www.ourcommons.ca/Content/House/421/Debates/056/HAN056-E.PDF; accessed February 24, 2017.
47. Industry Canada, *Amended and Restated Strategic Aerospace and Defence Initiative (“SADI”) Terms and Conditions* (Ottawa: Industry Canada, June 1, 2016); https://www.ic.gc.ca/eic/site/ito-oti.nsf/vwapj/SADI_TsCs_2016_06_15.pdf/$file/SADI_TsCs_2016_06_15.pdf; 4, 6; accessed February 24, 2017.
48. *House of Commons Debates*, 148 (69) (June 9, 2016): 4272, 4280; http://www.ourcommons.ca/Content/House/421/Debates/069/HAN069-E.PDF#page=3; accessed December 22, 2017.
49. See Canada, Parliament, House of Commons, Standing Committee on National Defence, *Subject Matter of Supplementary Estimates (B) 2016–2017: Evidence* (December 1, 2016): 6; http://www.ourcommons.ca/Content/Committee/421/NDDN/Evidence/EV8664335/NDDNEV32-E.PDF; accessed February 24, 2017; and “Ministerial Advisory Panel on Canada’s Defence Policy Review” (Ottawa: Government of Canada, April 6, 2016): 1–2; https://www.canada.ca/en/department-national-defence/news/2016/04/ministerial-advisory-panel-on-canada-s-defence-policy-review.html; accessed February 24, 2017; and Canada, Department of National Defence, “Canada Announces Plan to Replace Fighter Jet Fleet” (Ottawa: Department of National Defence, November 22, 2016): 1–2; https://www.canada.ca/en/department-national-defence/news/2016/11/canada-announces-plan-replace-fighter-fleet.html; accessed December 22, 2017. The defense consultation process concluded on July 31, 2016 and documentation, including public submissions, can be accessed at http://dgpaapp.forces.gc.ca/en/defence-policy-review/index.asp; accessed February 24, 2017.

50. See David Ljunggren and Leah Schnurr, "Canada, Cool on the F-35, Says Lockheed Jet Still an Option," *Reuters* (December 12, 2016): 1–2; http://www.reuters.com/article/us-usa-trump-lockheed-canada-idUSKBN14125C; accessed February 24, 2017; and Kim Richard Nossel, *Charlie Foxtrot: Fixing Defence Procurement in Canada* (Toronto: Dundurn, 2016).
51. See Canada, Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy* (Ottawa: DND, 2017): 38; http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf; accessed December 22, 2017.
52. Ibid., "Integrating Australian Air Jets into the Royal Canadian Air Fighter Fleet" (Ottawa: DND, December 22, 2017): 1–2; https://www.canada.ca/en/department-national-defence/news/2017/12/integrating_australianjetsintothecurrentroyalcanadianairforcefig.html; accessed December 22, 2017.
53. Public Works and Government Services Canada, "Future Fighter Capability Project - Suppliers List Invitation (W847A-180210/A)" (Ottawa: Public Works and Government Services Canada, December 12, 2017): 1–3; https://buyandsell.gc.ca/procurement-data/tender-notice/PW-NGF-002-26574; accessed December 22, 2017.
54. *Hansard Commons Debates*, 148 (197) (June 19, 2017): 12925; http://www.ourcommons.ca/Content/House/421/Debates/197/HAN197-E.PDF#page=37; accessed December 22, 2017.
55. Ibid., 148 (208) (September 28, 2017): 13724; http://www.ourcommons.ca/Content/House/421/Debates/208/HAN208-E.PDF#page=44; accessed December 22, 2017.
56. See Ibid., and *Hansards Common Debates*, 148 (230) (November 6, 2017): 15065; http://www.ourcommons.ca/Content/House/421/Debates/230/HAN230-E.PDF#page=75; accessed December 22, 2017.
57. See Ibid., 148 (235) (November 21, 2017): 15436; http://www.ourcommons.ca/Content/House/421/Debates/235/HAN235-E.PDF#page=82; accessed December 22, 2017; and Australian National Audit Office, *Management of Australia's Air Combat Capability-F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment* (Barton, ACT: Australian National Audit Office, 2012); https://www.anao.gov.au/sites/g/files/net4816/f/201213%20Audit%20Report%20No%205.pdf; accessed December 22, 2017.
58. Ibid., 148 (250) (December 12, 2017): 16345; http://www.ourcommons.ca/Content/House/421/Debates/250/HAN250-E.PDF#page=41; accessed December 22, 2017.
59. Public Services and Procurement Canada, "Replacing and Supplementing Canada's Fighters" (Ottawa: Public Services and Procurement Canada,

2018): http://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/CF-18-eng.html; accessed June 6, 2018.

60. *Canadian Forces Aerospace Shape Doctrine* (Ottawa: DND, 2014): 32; http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/ad-b-ga-403-000-fp-001.pdf; accessed February 24, 2017.

References

Auditor General of Canada. *Report of the Auditor General of Canada to the House of Commons: Chapter 2: Replacing Canada's Fighter Jets* (Ottawa: Auditor General of Canada, 2012): 1, 5. http://www.oag-bvg.gc.ca/internet/English/parl_oag_201204_02_e_36466.html. Accessed February 23, 2017.

Auger, Martin Auger. *The Evolution of Defence Procurement in Canada* (Ottawa: Library of Parliament, 2016). http://www.lop.parl.gc.ca/Content/LOP/ResearchPublications/2016-09-e.pdf. Accessed February 23, 2017.

Australian National Audit Office. *Management of Australia's Air Combat Capability-F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment* (Barton, ACT: Australian National Audit Office, 2012). https://www.anao.gov.au/sites/g/files/net4816/f/201213%20Audit%20Report%20No%205.pdf. Accessed December 22, 2017.

Bergh, Kristofer. *The Arctic Policies of Canada and the United States: Domestic Motives and International Context, SIPRI Insights on Peace and Security* (2012/1: July 2012). https://www.sipri.org/sites/default/files/files/insight/SIPRIInsight1201.pdf. Accessed June 6, 2018.

Canada Department of Justice. *Consolidation: Government Contracts Regulations SOR/87-402* (Ottawa: Department of Justice, 2018). http://laws-lois.justice.gc.ca/PDF/SOR-87-402.pdf. Accessed June 6, 2018.

Canada Department of National Defence. *Next Generation Fighter Capability Annual Update* (Ottawa: DND, 2012): 27. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/ngfc-annual-update-2012.pdf. Accessed March 27, 2017.

———. *Intelligence Assessment: Threat Capability Assessment for Canada's Fighter Aircraft Capability* (Ottawa: DND, 2013): 3. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2006%20Task%201%20(En)%20final.pdf. Accessed March 30, 2017.

———. *Next Generation Fighter Capability Annual Update 2014* (Ottawa: DND, 2014): ii–iii, 12, 21–22, 35. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/next-gen-fighter/2014/next-generation-fighter-capability-annual-update-2014-english.pdf. Accessed March 27, 2017.

———. *Canada Announces Plan to Replace Fighter Jet Fleet* (Ottawa: Department of National Defence (DND), November 22, 2016a): 1–2. https://www.canada.ca/en/department-national-defence/news/2016/11/canada-announces-plan-replace-fighter-fleet.html. Accessed December 22, 2016.
———. *Defense Policy Review* (Ottawa: DND, 2016b). http://dgpaapp.forces.gc.ca/en/defence-policy-review/index.asp. Accessed February 24, 2017.
———. *Integrating Australian Air Jets into the Royal Canadian Air Fighter Fleet* (Ottawa: DND, December 22, 2017a): 1–2. https://www.canada.ca/en/department-national-defence/news/2017/12/integrating_australianjetsintothecurrentroyalcanadianairforcefig.html. Accessed December 22, 2017.
———. *Strong, Secure, Engaged: Canada's Defence Policy* (Ottawa: DND, 2017b): 38. http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf. Accessed December 22, 2017.
———. *Future Fighter Capability Project* (Ottawa: DND, 2018): 1. http://www.forces.gc.ca/en/business-equipment/future-fighter-capability.page Accessed June 6, 2018.
Canada National Defence. *Canada First Defence Strategy* (Ottawa: DND, 2008): 4, 17. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/CFDS-SDCD-eng.pdf. Accessed March 25, 2017.
Canada. Minister of Indian Affairs and Northern Development. *Canada's Northern Strategy: Our Heritage, Our North, Our Future* (Ottawa: Public Works & Government Services Canada, 2008). http://www.northernstrategy.gc.ca/. Accessed March 19, 2017.
Canada. Parliament. *History of Federal Ridings Since* 1867*: General Elections 42-2015/10/19.* http://www.lop.parl.gc.ca/About/Parliament/FederalRidingsHistory/hfer.asp?Language=E&Search=G. Accessed February 23, 2017.
Canada. Parliament. House of Commons. *Debates*, 145 (66) (September 20, 2010): 4096. http://www.ourcommons.ca/Content/House/403/Debates/066/HAN066-E.PDF#page=32. Accessed March 23, 2017. Video at Canada, Parliament, Library of Parliament, *Parlvu*. http://parlvu.parl.gc.ca/Embed/en/i/3267388/?ml=en&vt=watch. Accessed March 23, 2017.
———. *Debates,* 145 (149) (March 25, 2011): 9257; 9284–9285. http://www.parl.gc.ca/content/hoc/House/403/Debates/149/HAN149-E.PDF. Accessed March 26, 2017. *Parlvu*. http://parlvu.parl.gc.ca/Embed/en/i/3827680/?ml=en&vt=watch. Accessed February 23, 2017.
———. *Debates,* 147 (10) (October 29, 2013): 519. http://www.parl.gc.ca/content/hoc/House/412/Debates/010/HAN010-E.PDF. Accessed March 30, 2017, *Parlvu*. http://parlvu.parl.gc.ca/Embed/en/i/8111262/?ml=en&vt=watch. Accessed February 23, 2017.
———. *Debates*, 148 (25) (February 25, 2016a): 1397–1398. http://www.ourcommons.ca/Content/House/421/Debates/025/HAN025-E.PDF.

Accessed February 24, 2017. *Parlvu*. http://parlvu.parl.gc.ca/Embed/en/i/8814970/?ml=en&vt=watch. Accessed February 24, 2017.
———. *Debates*, 148 (56) (May 16, 2016b): 3441. http://www.ourcommons.ca/Content/House/421/Debates/056/HAN056-E.PDF. Accessed February 24, 2017.
———. *Debates*, 148 (69) (June 9, 2016c): 4272, 4280. http://www.ourcommons.ca/Content/House/421/Debates/069/HAN069-E.PDF#page=3. Accessed December 22, 2017.
———. *Debates*, 148 (197) (June 19, 2017a): 12925. http://www.ourcommons.ca/Content/House/421/Debates/197/HAN197-E.PDF#page=37. Accessed December 22, 2017.
———. *Debates*, 148 (208) (September 28, 2017b): 13724. http://www.ourcommons.ca/Content/House/421/Debates/208/HAN208-E.PDF#page=44. Accessed December 22, 2017.
———. *Debates,* 148 (230) (November 6, 2017c): 15065. http://www.ourcommons.ca/Content/House/421/Debates/230/HAN230-E.PDF#page=75. Accessed December 22, 2017.
———. *Debates*, 148 (235) (November 21, 2017d): 15436. http://www.ourcommons.ca/Content/House/421/Debates/235/HAN235-E.PDF#page=82. Accessed December 22, 2017.
———. *Debates*, 148 (250) (December 12, 2017e): 16345. http://www.ourcommons.ca/Content/House/421/Debates/250/HAN250-E.PDF#page=41. Accessed December 22, 2017.
Canada. Parliament. House of Commons Standing Committee on National Defence. *Evidence: Monday, March 23, 2009* (Ottawa: Standing Committee on National Defence, 2009): 5. http://www.ourcommons.ca/Content/Committee/402/NDDN/Evidence/EV3760417/NDDNEV08-E.PDF. Accessed March 30, 2017.
———. *Next Generation of Fighter Aircraft* (Ottawa: Standing Committee on National Defence, 2010). http://www.parl.gc.ca/CommitteeBusiness/CommitteeMeetings.aspx?Cmte=NDDN&Language=E&Mode=1&Parl=40&Ses=3. Accessed March 26, 2017.
———. Standing Committee on Public Accounts. *Evidence: Tuesday,* May 1, 2012. www.ourcommons.ca/Content/Committee/411/PACP/Evidence/EV5534278/PACPEV41-E.PDF. Accessed March 26, 2017.
———. *Defence of North America: Evidence: Tuesday, April 29, 2014* (Ottawa: Standing Committee on National Defence, 2014): 11. http://www.ourcommons.ca/Content/Committee/412/NDDN/Evidence/EV6548239/NDDNEV21-E.PDF. Accessed March 30, 2017.
———. *Defence of North America: Evidence, Monday, February 16, 2015* (Ottawa: Standing Committee on National Defence, 2015): 4. http://www.ourcom-

mons.ca/Content/Committee/412/NDDN/Evidence/EV7835212/NDDNEV46-E.PDF. Accessed March 30, 2017.

———. *Subject Matter of Supplementary Estimates (B) (2016–2017): Evidence, Thursday, December 1, 2016* (Ottawa: Standing Committee on National Defence, 2016): 6. http://www.ourcommons.ca/Content/Committee/421/NDDN/Evidence/EV8664335/NDDNEV32-E.PDF. Accessed February 24, 2017.

Canada. Parliament. Standing Senate Committee on National Finance. *First Interim Report on the Main Estimates 2016–17: Fourth Report* (Ottawa: Standing Senate Committee on National Finance, 2016): 11. https://sencanada.ca/content/sen/committee/421/NFFN/Reports/NFFN-FourthReport-MainEstimatesFirstInterim_e.pdf. Accessed February 24, 2017.

Canada. Parliamentary Budget Officer. *An Estimate of the Fiscal Impact of Canada's Proposed Acquisition of the F-35 Lightning II Joint Strike Fighter* (Ottawa: Parliamentary Budget Officer, 2011a): 10, 24. http://www.pbo-dpb.gc.ca/files/files/Publications/F-35_Cost_Estimate_EN.pdf. Accessed March 26, 2017.

———. *Comparing PBO and DND Cost Estimates on Canada's Proposed Acquisition of the F-35 Joint Strike Fighter: Some Preliminary Questions and Answers on Key Issues* (Ottawa: Parliamentary Budget Officer, 2011b): 1–2. http://www.pbo-dpb.gc.ca/files/files/Publications/F35_QA_EN.pdf. Accessed March 26, 2017.

Canadian Forces. *Government of Canada Announces Comprehensive Response to Chapter 2 of the Spring 2012 Report of the Auditor General of Canada* (Ottawa: DND, April 3, 2012): 1. http://www.forces.gc.ca/en/news/article.page?doc=government-of-canada-announces-comprehensive-response-to-chapter-2-of-the-2012-spring-report-of-the-auditor-general-of-canada/hir3oy82. Accessed February 23, 2017.

Canadian Forces Aerospace Shape Doctrine (Ottawa: DND, 2014): 32. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/ad-b-ga-403-000-fp-001.pdf. Accessed February 24, 2017.

Chase, Steven. "Canada to Stay in Program of F-35 Jet Buyers Despite Pledge to Withdraw." *Globe and Mail* (February 24, 2016): 1–2. http://www.theglobeandmail.com/news/politics/canada-to-stay-in-program-of-f-35-jet-buyers-despite-pledge-to-withdraw/article28897002/. Accessed February 24, 2017.

Conley, Heather A., and Caroline Rohloff. "The New Ice Curtain: Russia's Strategic Reach to the Artic. A Report of the CSIS Europe Program." *Center for Strategic International Studies (CSIS)*. Lanham: Rowman & Littlefield, August 2015. https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/150826_Conley_NewIceCurtain_Web.pdf. Accessed August 14, 2018.

Deschamps, André. "Meet the F-35 Lightning II-Canada's Next Fighter." *Canadian Military Journal*, 11 (1) (Winter 2010): 49–52. http://www.journal.forces.gc.ca/vo11/no1/doc/10-deschamps-eng.pdf. Accessed March 26, 2017.

Elections Canada. *Report of the Chief Electoral Officer of Canada on the 41st General Election of May 2, 2011* (Ottawa: Elections Canada, 2011): 42. http://www.elections.ca/res/rep/off/sta_2011/stat_report2011_e.pdf. Accessed March 26, 2017.

F-35: The Politics of Procurement (Ottawa: Canadian Public Affairs Channel, 2011): 3:17–4:30. https://www.youtube.com/watch?v=gdrDn9uXh48. Accessed March 25, 2017.

Frear, Thomas, Łukasz Kulesa, and Ian Kearns. *Dangerous Brinkmanship: Close Military Encounters Between Russia and the West in 2014* (London: European Leadership Network, 2014): 5, 7, 17. http://www.europeanleadershipnetwork.org/medialibrary/2014/11/09/6375e3da/Dangerous%20Brinkmanship.pdf. Accessed March 30, 2017.

Granatstein, J.L. *Whose War Is It?: How Canada Can Survive in the Post 9/11 World* (Toronto: Harper Collins, 2007).

Industry Canada. *Canadian Industrial Participation in The F-35 Joint Strike Fighter Program* (Ottawa: Industry Canada, 2012): 14. https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Report_to_Parliament.pdf/$file/Report_to_Parliament.pdf. Accessed March 19, 2017.

———. *Canadian Industrial Participation in the F-35 Joint Strike Fighter Program* (Ottawa: Industry Canada, 2014): 5–6. https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Fall_2014_Report_Parliament.pdf/$file/Fall_2014_Report_Parliament.pdf. Accessed March 20, 2017.

———. *Amended and Restated Strategic Aerospace and Defence Initiative ("SADI") Terms and Conditions* (Ottawa: Industry Canada, June 1, 2016). https://www.ic.gc.ca/eic/site/ito-oti.nsf/vwapj/SADI_TsCs_2016_06_15.pdf/$file/SADI_TsCs_2016_06_15.pdf. 4, 6. Accessed February 24, 2017.

KPMG. *Next Generation Fighter Capability: Independent Review of Life Cycle Cost* (Ottawa: KPMG LLP, 2012): 2, 4, 14, 27. http://www.tbs-sct.gc.ca/reports-rapports/ngfc-cng/irlc-eiccv/irlc-eiccv-eng.pdf. Accessed March 27, 2017.

Lawson, General Tom. *The State of Canadian Armed Forces and Its Priorities* (Waterloo, ON: Center for International Governance Innovation, February 23, 2014). https://www.cigionline.org/events/state-canadian-armed-forces-and-its-priorities. Accessed February 23, 2017.

Ljunggren, David, and Leah Schnurr. "Canada, Cool on the F-35, Says Lockheed Jet Still an Option." *Reuters* (December 12, 2016): 1–2. http://www.reuters.com/article/us-usa-trump-lockheed-canada-idUSKBN14125C. Accessed February 24, 2017.

McKillip, J.D., and R.W.H. McKillip. "Point F35S and the Canadian 'Military-Technical Condition.'" *The Royal Canadian Air Force Journal*, 3 (3) (Summer 2014): 56. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss3-12-f35s-and-the-canadian-military-technical-condition.pdf. Accessed March 23, 2017.

"Ministerial Advisory Panel on Canada's Defence Policy Review" (Ottawa: Government of Canada, April 6, 2016): 1–2. https://www.canada.ca/en/department-national-defence/news/2016/04/ministerial-advisory-panel-on-canada-s-defence-policy-review.html. Accessed February 24, 2017.

New Democratic Party. *NDP Policy* (Ottawa: New Democratic Party, 2013): 19. https://charrois.files.wordpress.com/2015/02/ndp-policy-book.pdf. Accessed March 30, 2017.

Nossal, Kim Richard. "Late Learners: Canada, the F-35, and Lessons from the New Fighter Aircraft Program." *International Journal*, 68 (1) (Winter 2012–13): 167. https://doi.org/10.1177/0020702013068001111.

———. *Charlie Foxtrot: Fixing Defence Procurement in Canada* (Toronto: Dundurn, 2016).

Prime Minister of Canada. *Minister of National Defence Mandate Letter* (Ottawa: Prime Minister of Canada, 2015): 1. https://www.pm.gc.ca/eng/minister-national-defence-mandate-letter. Accessed February 24, 2017.

Public Services and Procurement Canada. "Replacing and Supplementing Canada's Fighters" (Ottawa: Public Services and Procurement Canada, 2018). http://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/CF-18-eng.html. Accessed June 6, 2018.

Public Works and Government Services Canada. "Future Fighter Capability Project – Suppliers List Invitation (W847A-180210/A)" (Ottawa: Public Works and Government Services Canada, December 12, 2017): 1–3. https://buyandsell.gc.ca/procurement-data/tender-notice/PW-NGF-002-26574. Accessed December 22, 2017.

Raymond Chabot Grant Thornton. Public Works and Government Services Canada. *Independent Review: 2013 Department of National Defence Annual Update on Next Generation Fighter Capability Life Cycle Costs* (Ottawa: Public Works and Government Services Canada, 2013): 10–11. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/ngfc-independent-review-2013.pdf. Accessed March 27, 2017.

Sanson and Associates. *Review of the Acquisition Process to Replace Canada's CF-18 Fleet* (Ottawa: Public Works and Government Services Canada, 2013): 12–18. https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/documents/flotte-fleet-18-eng.pdf. Accessed February 23, 2017.

Statistics Canada. *Table 1 Merchandise Trade: Canada's Top 10 Principal Trading Partners-Seasonally Adjusted, Current Dollars* (Ottawa: Statistics Canada, 2018). https://www150.statcan.gc.ca/n1/daily-quotidien/180606/t001a-eng.htm. Accessed June 6, 2018.

Stockholm International Peace Research Institute. *Military Expenditure Database* (Stockholm: Stockholm International Peace Research Institute, 2018). https://www.sipri.org/databases/milex. Accessed June 6, 2018.

Tago, Atushi, and Srdjan Vucetic. "The 'Only Choice': Canadian and Japanese F-35 Decisions Compared." *International Journal*, 68 (1) (Winter 2012–13): 133. https://doi.org/10.1177/002070201306800109.

"Tories Freeze F-35 Funds and Open Door to Alternatives in Wake of Scathing AG Report." *National Post* (April 3, 2012): 1–4. http://news.nationalpost.com/news/canada/tories-freeze-f-35-funds-and-open-door-to-alternatives-in-wake-of-scathing-ag-report. Accessed February 23, 2017.

Wright, David Curtis. *The Dragon Eyes the Top of the World: Arctic Policy Debate and Discussion in China* (Newport, RI: China Maritime Studies Institute, U.S. Naval War College, 2011). http://digital-commons.usnwc.edu/cmsi-red-books/2/. Accessed March 19, 2017.

CHAPTER 7

JSF and the United Kingdom

Britain is a Level 1 JSF partner having contributed $7.618 billion to the project as of 2015, getting 25% say in the project and 100% in benefits with the United States, and has invested significant resources into this project though there have been moments of acute tension in Anglo-American relations during this program's protracted development span. In July 2017 a *Times of London* report noted that British JSF per plane expenditures were expected to reach between $104.364 million and $105.538 million, with overall program expenditure on these and aircraft carriers expected to reach $16.264 billion by 2021. A December 2017 House of Commons Defence Select Committee report on JSF costs estimated that these would reach $12.207.3 billion through 2026. While London is interested in diversifying its defense industrial supply, it recognizes the critical importance of maintaining interoperability with US forces and maintaining historically close collaboration with the United States on defense issues.[1]

Britain's interest in the JSF began during the Joint Advanced Strike Technology (JAST) program when John Major's (CON—Huntingdon) Conservative Government signed a Memorandum of Understanding in 1995 to join the concept demonstration phase.[2] On December 10, 1996, James Arbuthnot, the Ministry of Defence's (MOD) Minister of State for Procurement (CON—Wanstead & Woodford), told the House of

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_7

Commons that MOD had contributed $13.022.539 million to the United States for the JSF program and that MOD anticipated contributing $200 million between 1996 and 2000.[3]

Blair Government

The July 8, 1998, White Paper saw Prime Minister Tony Blair's (LAB—Sedgefield) Labour Government release its *Strategic Defence Review*. It advocated purchasing the JSF as a fixed-wing component for the Royal Navy (RN) while also recognizing that the increasing costs of high-technology weapons systems made globally produced defense projects like the JSF more common. On July 21, 1998, Secretary of State for Defence John Spellar (LAB—Warley) told the House of Commons that the United Kingdom was participating as a collaborative partner in the JSF Concept Demonstration Phase and that steady progress was being made for the planned 2000 first flights of the Concept Determination aircraft.[4]

This time period also saw MOD focus on the need to replace its carrier-based Harrier aircraft and the offensive capabilities of the land-based Tornado fighter fleet. Initially, MOD decided to purchase the Eurofighter Typhoon fighters for air defense and offensive air support. The Eurofighter remains part of Britain's military airpower assets, but the need to maintain close interoperability with the United States led to enhanced British interest in becoming part of the JSF.[5]

In January 2001, MOD announced that the JSF had the best potential to meet UK joint combat aircraft requirements and London entered the program's demonstration phase by participating in the JSF System Development Phase which would prove to be the first of a projected five-main gate stages in the British JSF ordering process. October 2001 saw British Aerospace Systems (BAE) join Lockheed Martin and Northrop Grumman as the prime contractors. MOD announced that British involvement in this JSF phase would create or sustain 5000 new jobs in approximately 70 British companies. During this time the Royal Air Force (RAF) military professional journal announced that JSF would be one of four platforms dominating stealthy air forces in 2020. In September 2002, MOD announced that the United Kingdom had selected the STOVL version of JSF over the US F/A-18E, France's Rafale M, a "navalized Eurofighter," and an advanced Harrier to meet the United Kingdom's requirements since these other aircraft were not viewed as cost-effective.[6]

A December 21, 2005, report by the House of Commons Defence Select Committee noted that JSF carrier weight problems had been lessened, but that risks remained and must be monitored closely. This document and a National Audit Office (NAO) document mentioned that the JSF's targeted UK carrier deployment had slipped from 2012 to 2014. Committee members also stressed concern that the United Kingdom would not have access to all appropriate JSF information and technology, contending:

> It is vital that the UK gets all the information and access to technology it requires from the US to have "Sovereign Capability"—the ability to maintain the Joint Strike Fighter aircraft and undertake upgrades independently. The UK must receive adequate assurances that it will get all the information and access to technology it requires before the programme is to far advanced. If these assurances are not given, it is questionable whether the UK should continue its involvement in the programme.[7]

This parliamentary document went on to say that it anticipated Britain buying up to 150 STOVL aircraft, noted with concern Senator Carl Levin's (D—MI) statement to *Aviation Week and Space Technology* in October 2005 that the JSF could be trimmed back due to budget pressures, and also commented on Secretary of Defense Donald Rumsfeld's November 2005 assertion that JSF would receive generous funding in the US FY 2007 budget request to be submitted in February 2006.[8]

In December 12, 2006, Lord Drayson, the Minister of State for Defence Equipment and Support, approved the business case to participate in JSF's Production, Sustainment, and Follow-on Development Phase entering the second Main Gate of British JSF procurement activity.[9]

A critical problem in Britain's JSF collaboration with the United States was Washington's refusal to share stealth technologies with London such as radar-absorbing paint, software source code foundational to JSF equipment and weapons integration, and agreements covering follow-up development of aftermarket capabilities due to the US rigid interpretation of International Traffic in Arms Regulations (ITAR) rules authorizing presidential control of defense article exports under the Arms Export Control Act (AECA). This is a subject which has complicated allied country collaboration with the United States on the JSF. During late 2005, the British seriously considered transferring the preponderance of their arms acquisitions to European suppliers, but the United States agreed to British concerns on this subject and reached agreement in 2007.[10] This agreement would be set back in late 2009 when the US JSF international affairs leader Jim Schreiber said the United States would keep all of the JSF's software coding and the agreement was not ratified by the US Congress until 2010.[11]

Brown Government

Delays and cost concerns continued plaguing the British JSF during Gordon Brown's (LAB—Kirkcaldy and Cowdenbeath) Government between 2007 and 2010. A March 2008 House of Commons Defence Select Committee report expressed disappointment learning that MOD could not guarantee that JSF would be available for aircraft carrier deployment in 2014 and that existing Harrier G9 aircraft would remain in service until 2018. An earlier 2005 investigation by this committee announced that MOD had told them that it anticipated buying 150 STOVL aircraft. However by 2008, MOD said the target number of JSF's to be purchased depended on their cost with MOD's Chief of Defence Material General Sir Kevin O'Donoghue saying during a January 29, 2008, hearing before this committee, "It would be foolish of me to suggest a number without knowing the price." In addition, MOD Chief Operating Officer David Gould said that production cost growth of 20–30% had occurred with the F-18 program, but that he had not seen any evidence of this happening with the JSF. Gould also said he was confident MOD could afford 36 JSF aircraft on each aircraft carrier. When asked by the committee if the original goal of buying 150 aircraft was "cloud cuckoo land," O'Donoghue maintained he was "not sure if we need to decide on a number now."[12]

The government responded to the committee's concerns on June 10, 2008, by noting that MOD was still finalizing its plans for transitioning from the Harrier to the JSF. It also stressed the complexities inherent in multinational procurement projects:

> The development and subsequent manufacture and delivery of defence equipment is technically challenging and often involves leading edge technologies. Undertaking programmes with international partners involves many of the same risks associated with programmes pursued independently. A key issue is to ensure the risks are well understood and sufficient provision is made for them at the outset to secure a good foundation. It also requires an appreciation by all the participating nations of the broader risks associ-

> ated with collaborating, for example, differing budgetary and approval regimes or technical clearance requirements, and allowing for these. Collaboration is a very powerful vehicle for sharing non-recurring costs, risk, technologies and knowledge as well as leveraging the benefits of economies of scale associated with larger numbers. It also allows nations to pursue a capability that would be beyond its means to pursue independently.[13]

In March 2009, approval was given for the Third Main Gate involving procuring aircraft for Joint Operational Test and Evaluation. This same year also saw an order placed for two operational JSF tests and evaluation for anticipated delivery in 2012. These two aircraft were eventually delivered on July 19, 2012, at Lockheed Martin's JSF facility in Fort Worth, TX, and in October 2012 at Florida's Eglin Air Force Base where British fighters and engineers receive training to operate the aircraft.[14]

Cameron Government

The 2010 *Strategic Defense and Security Review (SDSR)* initiated by the new Conservative-Liberal Democrat coalition government of Prime Minister David Cameron (CON—Witney) and Deputy Prime Minister Nick Clegg (LIBD—Sheffield, Hallam) stressed that the RN would build a catapult to an operational carrier to fly a version of the JSF with longer range and greater weapons capacity, instead of the STOVL version, to enhance British interoperability with the American and French navies. The 2010 SDSR also announced that the RAF would be structured around the Eurofighter Typhoon for air-to-air and air-to-ground missions and the JSF for multirole combat by the 2020s. Additional rationale espoused by SDSR on the need for JSF's acquisition includes recognizing the more than three-decade-old age of the Harrier and Tornado air defense and ground attack aircraft; the ability of Typhoon and JSF to operate independently in challenging environments; carrying various electronic sensors to achieve an unprecedented picture of adjacent threats, and being able to share with other UK and allied air, ground, and maritime forces.

These decisions, including defense spending and force reduction cuts with the government pledging adherence to the North Atlantic Treaty Organization's targeted goal of 2% of GDP being allocated to defense spending, were publicly verified by Cameron during Prime Minister's Questions on October 19, 2010, when he criticized the Labour Government's purchasing what he regarded as a more expensive and less capable JSF version to fly off carriers. Force and weapons systems reductions implemented as a result of SDSR included canceling the £3 billion Nimrod maritime patrol and attack aircraft; reducing Army personnel from 102,500 to 95,500 between 2010 and 2015; reducing RN personnel from 35,000 to 30,000 and frigates and destroyers from 23 to 19 between 2010 and 2015; and reducing RAF manpower from 38,000 to 33,000 between 2010 and 2015.[15]

Frustration with continual JSF cost increases and delays was reflected during a July 11, 2011, hearing by the House of Commons Public Accounts Committee examining problems with the carrier strike element of MOD's JSF program. The following exchange between committee chair MP Margaret Hodge (LAB—Barking), Ursula Brennan, MOD's Permanent Undersecretary, and Rear Admiral Amjad Hussain, CB, the Director (Precision Attack) and Controller of the Navy illustrates the ongoing frustrations experienced by parliamentary appropriators and the lack of fiscal precision provided by MOD personnel to a report by the NAO and MOD Comptroller:

Hodge:	One of the real irritating things about the MOD is to get some certainty. The figure in the Report says £800 million to £1.2 billion. Can you give this Committee an assurance that the MOD, under your leadership and with Rear Admiral Hussain being the Responsible officer, will not in the future exceed £1.2 billion—I am being generous to you—in the actual costs of conversion?
Rear Admiral Amjad Hussain:	I do not think as this stage one can give an absolute guarantee. We work in terms of possibilities, and our estimates are pretty well founded.
Hodge:	Your estimates are usually wrong.
Rear Admiral Amjad Hussein:	The estimates are quite well-founded. I would not expect it to exceed that cost, but there are a number of levers to pull across this carrier programme. The cats-and-traps cost in isolation should not be taken away from the cost of the aircraft.

Hodge: You gave me an answer to that, which is that you cannot assure the Committee that, at the higher figure of the cost of conversion in our Report, you can stand by that. That is an estimate; it is not an actual cost.

Brennan: It is currently an estimate and, until the work is completed, remains an estimate. We believe that it is a good estimate but, until it is definitively nailed down and contracted for, we cannot give you a guarantee about that.[16]

Frustration with JSF delays was not limited to the opposition Labour Party. MP Stephen Barclay (CON—North East Cambridgeshire) asked Brennan if there was a distinction between a policy issue and a value-for-money issue. Brennan responded by contending whether the United Kingdom wanting a carrier strike capability was the big policy issue and that the changed type of aircraft on the carrier brings the best value for money and most bang for the buck.[17]

This parliamentary frustration was reflected in the Committee's November 23, 2011, report on the carrier strike capability with key document determinations including:

- The committee's ability to hold departments accountable and deliver value for money was limited by NAO not having access to all information it needed when preparing this report;
- Converting the ship from the STOVL variant to the carrier variant has changed the risk and costs profile with the costs not being known until December 2012, leaving the project at risk of cost growth and delays along with new technical risks and challenges integrating the new aircraft with the carriers;
- MOD has entered into commercial agreements without assurance it has the budget to meet its commitments resulting in a shortfall of up to £38 billion over the next ten years;
- Deciding to withdraw current carriers and Harrier aircraft has produced a nine-year gap when the United Kingdom will have no carrier strike capability;
- There is no individual responsible for delivering the Carrier Strike project below the MOD Accounting Officer.[18]

During Spring 2012 it was revealed that JSF carrier flight desk program costs had risen from £500 million to £1.8 billion. Concerns were expressed in press and governmental reports on the positioning of the aircraft arrestor hook; risks with the Electromagnetic Aircraft Launch System (EMALS); the potential need for air-to-air-refueling capability when aircraft are unable to land on the flight point; and the United Kingdom's lack of experience operating the carrier version. Such concerns prompted Shadow Defence Secretary Jim Murphy (LAB—East Renfrewshire) to write the Secretary of State for Defence on March 2, 2012, asking whether MOD was reconsidering its 2010 decision to abandon the F-35's STOVL variant.[19]

An analysis of the technological complexity and the increased costs of the JSF make the following assertion:

> While critiques of the acquisition process are credible, it is hard to escape the conclusion that even with a perfectly designed project, governments working on the cutting edge of technology will see costs increase. The software lines of code for the JSF now number over 34 million. Thus the JSF validates what may be the crux of any such initiative: acquisition decisions based on the initial estimate of the price of the item will invariably be incorrect. The only question is the size of the cost increase. For policymakers, that should indicate a calculation on whether the risk involved in getting the best technology is excessively high and involves a potentially unacceptable cost.[20]

These recurring concerns prompted Secretary of State for Defence Philip Hammond (CON—Runnymede and Weybridge) to announce in Parliament on May 10, 2012, that the cost and technical design concerns compelled the government to reverse its 2010 SDSR decision to proceed with JSF's carrier version and that it would return to the F-35B STOVL variant. In his announcement, Hammond mentioned that catapult launch system costs to the *HMS Prince of Wales* had more than doubled from £950 million to £2 billion, that the costs of making the necessary refits to the aircraft carrier *HMS Queen Elizabeth* would be between £2.5 and £3 billion pounds, and that it was highly unlikely this ship would ever be converted. Hammond went on to mention that this decision would not delay aircraft delivery.[21]

This policy reversal was denounced by Murphy, who described the carrier program as "chaotic" and maintained that it represented the loss of two years and a waste of £250 million. This decision received a mixed reaction in the British defense community with former Chief of Defence Staff Sir David Richards noting impressive improvements to STOVL aircraft since the 2010 SDSR and that the strategic balance had tipped in favor of STOVL. In contrast, Rear Admiral Chris Parry, the former MOD

Doctrine Director, criticized the decision to revert to the F-35B instead of what he considers the more capable F-35C by suggesting this decision was geared toward short-term cost-saving factors instead of a desire to provide financial value and long-term strategic utility. Parry also expressed concern about the absence of air-to-air refueling capability on the carriers and the subsequent reliance on land-based aircraft.[22]

In July 2012, the United Kingdom announced it had committed to 48 aircraft while refusing to specifically commit on the exact number of aircraft it would order. On February 5, 2014, MOD announced that the NAO 2012 *Major Project Report* had listed the JSF approved cost as being £2.716 billion and its forecast cost as being £2.344 billion. Minister for Defence Equipment Philip Dunne (CON—Ludlow) also announced that not until 2017 would the government be able to have a conclusive cost estimate which would affect how many JSF aircraft would be ordered.[23]

Further problems prompting the JSF carrier reversion decision were revealed in a May 2013 NAO report noting the flawed and immature data assumptions behind 2010 SDSR decision-making, EMALS conversion cost increases rising from £800 million to £2 billion, and the realization that there were interoperability problems with both US and French aircraft carriers and weapons systems.[24]

January 2014 saw HM Treasury approve Main Gate 4 which involved purchasing aircraft and support to deliver Initial Operating Capability scheduled for 2018. This covers purchasing of the first operational squadron of 14 aircraft, associated support equipment and spare parts, and all associated support contracts up to 2020. The JSF's Initial Operating Capability is set for December 31, 2018. November 24, 2014, saw the initial contracts signed for the first four aircraft with an approved budget cost of £2.75 billion, with the actual forecast cost expected to be £2.42 billion due to an accounting adjustment removing £204 million for potential future foreign exchange rate movements and decreased risks and uncertainty levels. The bulk purchase of JSF aircraft was expected to occur in 2017.[25]

British JSF Contractors

British JSF contractors, with a workforce of nearly 25,000, are scattered around the country with most being in the Northwest, many being in the southwest and East Midlands, and slightly fewer being in the southeast. JSF impacts nearly all areas of the United Kingdom including Scotland and Wales. Table 7.1 lists the contractors and selected subcontractors, selected components produced, and selected geographic production locations.

Table 7.1 Selected British JSF contractors[26]

BAE Systems Stevenage; Nottingham; Isle of Wight; Sheffield; Manchester	Aft fuselage and structural components; vertical and horizontal tails; CV Wing tips; vehicle; weapons integration; throttle quadrant
Cobham Hampshire	Design, qualification, and manufacture of air refueling probe
GE Aviation Systems London; Hants; Barnstaple; Newmarket; Tewksbury,	Electrical power management system; battery charger; standby flight display; connectors; fabrication, printed circuit boards; fuselage remote interface units; tactical data equipment
Gentex Coventry	Helmet integrated systems
Goodrich Actuation Systems Bedhampton; Derby; Milton Keynes; Penny & Giles	Developing complete drive system for JSF weapons bay door, including electronic control unit; supplying flight and propulsion system activators for F-35B STOVL
Honeywell Normalair-Garrett Yeovil	Cockpit life-support system
Martin-Baker Aircraft Company Warwick; Stevenston; High Wycombe; Douglas; Oxford	US16E ejection seat for all F-35 versions
MBDA Bolton; Bristol; London; Stevenage; Summerfield	Integrating Advanced Short-Range Air-to-Air Missile (AMRAAM) for the United Kingdom; long-range, deep-strike cruise missile; Brimstone air-to-surface precision strike weapon
MOOG Tewkesbury; Wolverhampton; Luton	Primary Flight Control; leading-edge actuation system
RFD Beaufort Merseyside; Dunmurry; Southampton	Design, manufacture, and distribution of Pilot Flight Equipment, including fully integrated, modular and interchangeable solution to maximize protection and optimize pilot performance
Rolls-Royce Derby; Rotherham; Sheffield; Wolverhampton	STOVL lift system; lift fan; roll ducts; 3-Bearing Swivel Nozzle
Selex Edinburgh	Electro-optical targeting laser
Stirling Dynamics Bristol	Stick and throttle for trainers

(*continued*)

Table 7.1 (continued)

Survitec Great Yarmouth; Grimsby, Edinburgh	Pilot flight equipment
Ultra Electronics Cheltenham; Greenford; High Wycombe; Weymouth	Engine ice protection systems on the main JSF engine (F-135); lift fan engine; Suspension and release equipment
UTC Aerospace Systems Malvern; Plymouth; Wolverhampton	Weapons bay, door drive

These companies are part of the United Kingdom's overall defense industry generating revenue of over £22 billion in 2012, average annual exports exceeding £6.5 billion over the past decade, directly employing a domestic workforce of 162,400, and building 15% of the planned 3000 Lockheed Martin JSF fleet. During 2016, the UK aerospace sector generated over £31 billion in revenue from a workforce of 95,000 with southwest England and the East Midlands accounting for 43% of this workforce and nearly 90% of its output is exported. British defense industry expertise with JSF technology gives it the authority to have an open export license for this technology to countries participating in this program including Australia, Canada, Denmark, Israel, Italy, Japan, the Netherlands, Norway, South Korea, Turkey, and the United States.[27]

This widespread dispersion of JSF-related workforce throughout the United Kingdom, from constituencies represented by all major British political parties, ensures maintenance of significant support levels for the JSF regardless of the financial costs involved. This is reflected in the presence of an F-35 aviation and avionic element repair hub at Sealand in Northeast Wales which MOD announced supported 400 jobs on November 7, 2016.[28]

RAF and RN pilots have been training with the United States Marine Corps (USMC) in partnerships initially and later at the Marine Corps Air Station (MCAS) in Beaufort, SC. The RAF's 617 Squadron was formed in 2016 at MCAS Beaufort before moving to RAF Marham in 2018. JSF flight testing is expected to occur in US waters on the *HMS Queen Elizabeth* between 2018 and May 2019 by the No. 17 Test and Evaluation Squadron. The JSF Lightning II is expected to be the first aircraft to fly from the *Queen Elizabeth* according to a December 17, 2014, statement made to the Commons Defence Committee by Defense Secretary Michael Fallon (CON—Sevenoaks).[29]

These trends have not been significantly affected by the results of the May 7, 2015, British election which resulted in a majority Conservative victory.[30] Britain will eventually deploy some form of the JSF. However, the numbers and effectiveness of this fleet and Britain's financial willingness to sustain this fleet and its overall defense capabilities have been uncertain. British defense spending has declined from £41.3 billion annually in 2010/11 to £36.4 billion in 2013/14 and to £35.1 billion in 2015/16 and rising to £35.3 billion for 2016/17 while also declining from 5.9% of government spending in 2010/11 to 5.3% in 2013/14 from a 6.7% share of government spending between 2001 and 2003 though rising to 6% of government spending in 2017.[31]

Concerns about Britain's financial willingness to sustain its defense obligations were reflected in a parliamentary Early Day Motion (a document recommending debate on a topic) tabled on February 3, 2015, by MP Peter Luff (CON—Mid Worcestershire) and signed by 32 additional MPs representing all parliamentary political parties. Stressing concern over unforeseen emerging threats to British security such as the Ukraine crisis, this document urges the government elected in the May 2015 elections to adopt effective and properly funded defense, development, and diplomatic policies to meet these threats; favors the United Kingdom spending at least 2% of its GDP on defense; and including 1% annual increases in the defense equipment budget.[32]

This financial willingness or unwillingness to support the 2% defense spending GDP threshold was debated in the House of Commons on March 12, 2015, for over 3½ hours with an accompanying motion favoring this spending level passing 37-3. Gisela Stuart (LAB—Birmingham, Edgbaston) noted that defense spending represented 2.5% of GDP in 2010 and 2% in 2015. John Baron (CON—Basildon and Billericay) mentioned increasing Russian aggressiveness in UK airspace and noted the Defence Secretary's comment that Russian aggression posed a real danger to Estonia, Latvia, and Lithuania by arguing:

> The heft of a strong military underpins a successful foreign policy. By contrast, a shrinking defence budget threatens our ability to lead global opinion, reduces our foreign policy options and, crucially, sends the wrong message both to our allies and to potential adversaries. It is doubtful that President Putin would operate as he is now if he thought that NATO, especially the European NATO members, would robustly stand up to him.[33]

Additional salient arguments were presented by Defence Committee Chair Rory Stewart (CON—Penrith and The Border). He noted that the reemergence of a threat from a single state (Russia); that the emergence of hostile security environments in Afghanistan, Libya, South Sudan, Syria, Western Iraq, and Yemen; that more defense spending was needed to deal with conventional threats from Russia and concurrent threats from fragile states harboring Islamist terrorist groups; and that these required new force structures and spending. Malcolm Rifkin (IND—Kensington) noted what he saw as the government's imperative to assume leadership, even if it was unpopular, on increasing defense spending with the following observations:

> What I beg of the Government, or any Government who emerge after the general election, is that they do not ask the facile question, "Does this win votes? Are the public demanding it? Is this therefore something we must respond to, or it will hurt us politically?" If a Government have one justification in a democratic society, it is that they do not just follow, or seek to follow, public opinion, but occasionally recognise the need to lead public opinion, and to take decisions that may involve painful choices, and that may be difficult in terms of newspaper headlines, but may have profound and beneficial impacts on our ability to make our contribution to sorting out some of the problems of the world.[34]

Another important development in the future status of the JSF will be the findings of the 2015 SDSR. Updating the coalition government's 2010 SDSR, this document follows the pattern of the US *Quadrennial Defense Review* in describing national security strategies while also reflecting political and financial constraints which have limited and may continue restricting Britain's ability to meet its immediate national security interests and its broader strategic relationships with the United States and other allies. This could make it extremely difficult for Britain to decisively increase its military spending regardless of ongoing Russian threats (demonstrated by RAF jets scrambling more than 40 times since Cameron became Prime Minister to prevent Russian military planes such as bombers from entering UK airspace) or US pressures for increased defense spending.[35]

The willingness of Britain to sustain its military capabilities remains an open question in an environment of increasing Russian geopolitical aggressiveness, the rise of Islamist terrorism such as ISIS, and cyberterrorism coupled with recently listed declines in defense spending under the

Cameron Government. While there is support for robust defense spending among the Conservatives and some Labour Party members, it is not supported by the Scottish National Party whose defense policy was described by an informed observer as "simple wishful thinking."[36]

The 2015 SDSR was released on November 23, 2015, and took a more robust and assertive posture toward British defense spending and power projection than its 2010 predecessor. It called for a maritime task group featuring the JSF on a *Queen Elizabeth* Class aircraft carrier, increasing JSF purchases in the early 2020s, establishing an initial JSF squadron in the RAF while buying 138 JSFs over the program's life, collaborating with the United States on building and supporting the JSF, and increasing interoperability with the US Parliamentary debate on the SDSR's release saw MP Nigel Evans (CON—Ribble Valley) comment that the November 13 Paris terrorist attacks stressed the importance of the RAF having necessary resources including the JSF and Typhoon fighters.[37]

May Government

Further British procurement of JSF-related equipment was announced on August 16, 2016, when Minister for Defence Procurement Harriet Baldwin (CON—West Worcestershire) awarded a £184 million contract to MBDA Missile Systems to arm the JSF with an air-to-air missile which will enable its use beyond 2022. This missile will use a sophisticated infrared seeker enabling pilots to engage and defend against other aircraft while engaging hostile aerial targets ranging from small drones to large multi-engine aircraft.[38]

The JSF remains the subject of British parliamentary debate and scrutiny and assessment by the NAO before and after the June 23, 2016, Brexit vote which resulted in Cameron's resignation and his replacement as prime minister by Theresa May (CON—Maidstone).[39] On July 2, 2015, Alan Mak (CON—Havant) noted that conventional forces remain highly relevant in a world of potential cyber and chemical attacks. He also observed that forthcoming defense spending programs in areas such as the JSF, aircraft carriers, armored vehicles, and attack helicopters reflect wisely on this emerging security environment while also stressing the important role that defense contractors such as Eaton Aerospace and Lockheed Martin play in his parliamentary constituency.[40] However, concern over the JSF's cost was reflected in February 2, 2017, Commons debate by Kirsten Oswald (SNP—East Renfrewshire) who maintained that JSF, the

Poseidon maritime patrol aircraft, and other defense spending of £24.4 billion pounds represented a fiscal "black hole" which she described the government as inheriting from its Labor predecessors.[41]

An April 12, 2016, Commons Defence Committee report on British defense spending quoted Justin Bronk of the Royal United Services Institute (RUSI) contending the following about JSF costs and benefits:

> The F-35 represents a significant challenge and a significant opportunity in the realm of training and maintenance for the UK. On the one hand, operating the single-seat, stealthy jet effectively and training pilots with advanced and highly sensitive capabilities will require significant investment in next-generation synthetic training facilities and networks. On the other, these investments will enable the UK to train for complex, high-threat war-fighting situations affordably and regularly in a way that can currently only be done at great expense in the US.[42]

This report also asserted that if the United Kingdom upgrades cross-platform interoperability then the JSF's efficiency and impact will be enhanced considerably, but if such investments are not made there could be significant waste in the United Kingdom's JSF potential.[43]

A June 28, 2016, report by this committee noted increasing Russian aerial aggression in UK airspace and waters and in other theaters of operation. This included Iranian transfer of SU-25 aircraft to Iraq to fight Daesh, using MiG-31 aircraft to threaten Baltic States, buzzing a US destroyer in the Baltic Sea on April 11–12, 2016, inducing the June 2014 closure of a US air transit center in Kyrgyzstan, the United Kingdom being forced to ask NATO for maritime patrol aircraft to track a Russian submarine in British waters, and a disparity of 1084–1094 in tactical aircraft between Russia and the United Kingdom reflecting London's acute unilateral airpower inferiority to Moscow.[44]

A January 31, 2017, hearing by this committee saw Madeline Moon (LAB—Bridgend) question Baldwin about various JSF procurement matters including the JSF's off-the-shelf procurement. Baldwin stressed that Britain was building 15% of the JSF aircraft emphasizing that the United States recognized the existence of a two-way bilateral relationship between these two countries on this aircraft. Moon noted President Trump's recent denunciation of JSF costs and his emphasis on "America First" in its policies. She went on to ask Baldwin if the United Kingdom would adopt a "Britain First" defense procurement strategy. Baldwin responded saying the United Kingdom strongly supports Trump's efforts to reduce JSF costs, that the United Kingdom is open to partnering with other countries to share defense costs, and that Britain sees Brexit as an opportunity to work closely with European allies citing the Typhoon and A400M strategic and tactical airlift aircraft as precedents. Lt. General Mark Poffley (Deputy Chief of Defence Staff for Military Capability) went on to emphasize that the JSF was the right platform for the United Kingdom to purchase, that UK involvement in this project is "second to none," and that the United States is not reducing its commitment to the JSF.[45]

The October 22, 2015, NAO report on defense equipment planning out to 2025 noted improving support elements in the JSF program. These included the current forecast cost to completion being £4.947 billion with the expected cost to completion being £5.622 billion; forecast assessment cost being £144 million as opposed to an approved £150 million; and the JSF's forecast in-service date being December 2018.[46] A June 14, 2016, NAO report on funding requirements stemming from the 2015 SDSR noted that MOD plans equipment spending of £178 million between 2016 and 2026, and that the number of JSFs employed on aircraft carriers beginning in the 2020s will increase from 15 to 24.[47]

NAO's January 26, 2017, report on MOD's equipment plan from 2016 to 2026 noted that projected JSF expenditures were £471 million and reaffirmed Britain's commitment to buy 138 aircraft. This report also noted that nearly £6 billion in extra savings would need to occur or the ability to purchase new planes and tanks would be jeopardized.[48]

Further 2017 Developments

May's government appeared stable in the early months of 2017 due to the disarray then experienced by the Labour Party under Jeremy Corbyn (LAB—Islington North) seeming to make the JSF prospects reasonably promising for the foreseeable future. On March 8, 2017, Chancellor of the Exchequer Philip Hammond presented the 2017/2018 budget to the House of Commons. In his speech, Hammond maintained that Britain's economy was experiencing robust growth which was faster than France, Japan, and the United States; that the budget deficit had been reduced by two-thirds; that unemployment was at a 11-year low; that the United Kingdom was in a strong financial position as it begins Brexit negotiations; and that national debt would fall in the future. Defense spending was projected to rise to £48 billion for 2017/2018, representing 5.98% of projected government spending and allowing for funding to continue JSF acquisition and program participation.[49]

The strength of May's Government and potential prospects for the JSF took a hit when she made an ill-advised call for a snap parliamentary election on June 8, 2017, in an effort to increase its majority. This election actually saw her government lose its majority and have to enter a confidence and supply agreement with Northern Ireland's Democratic Unionist Party to retain power.[50] Another blow to JSF fortunes occurred in a July 17, 2017, *Times of London* investigation which documented rising costs and various technical problems with the JSF including:

- The Lightning cannot transmit data to British ships or older planes without revealing its position to an enemy.
- Broadband on Britain's principal aircraft carrier *HMS Queen Elizabeth* is four times weaker than the average British household severely restricting the JSF's abilities.
- A test pilot had to land the JSF in almost total darkness after night vision failed in the plane's $418,000 helmet.
- The section of MOD responsible for JSP computer network operations must find over $460 million in savings this year.
- Updating satellite broadband across the RAF and RN to communicate securely would cost nearly $1.356 billion.
- Maneuverability is bad, flying fast at low altitude is problematic; when overheating occurs bomb bay doors must be opened to cool the missiles that are inside, and logistics computers cripple the ability to move the JSF from one airfield to another.[51]

Defence Procurement Minister Baldwin told Conservative Commons parliamentarians that newspaper reports were "out of date, lack technical understanding of complex issues, and contain commentary that is ill-informed and inaccurate." She also added that "where concerns are valid they are not new, have been reported in recent years, and are being addressed as part of the trials."[52]

The Commons Defence Committee launched a further investigation into the JSF's procurement status on September 12, 2017, holding a public hearing on that date and on October 17, 2017, before releasing its report on December 12, 2017. The Committee's report expressed strong displeasure that the MOD was unable to supply for specific JSF cost figures than $105 million per aircraft and a total of $12.207.3 billion out to

2026 including the first 48 aircraft, spares, support, training, and infrastructure investment at RAF Marham and other locales. This section of this report excoriated the lack of fiscal transparency saying it was unacceptable and risked undermining public confidence in the program and that MOD should provide "rough orders of magnitude" it claims to have for JSF costs beyond 2026–2027.[53]

Evidence presented to this committee by Lockheed Martin on November 17, 2017, said that program problems raised in *The Times* investigation were historic and had been resolved; that software changes had been made to improve helmet night vision imaging at sea and that pilots are able to change helmet display to better reflect operating conditions; that no thermal restrictions exist on aircraft weapon bay doors during flight, that cybersecurity testing occurs continually and is robustly resourced; and that JSF can communicate fifth-generation situational awareness to legacy platforms.[54]

Subsequent documentation submitted to this committee by MOD stressed that the JSF is on-time, within costs, and offers the best capability for British military forces, that it is the world's most advance fighter jet, that the JSF is a formidable fighting force whether deployed from the *Queen Elizabeth* or land, and that past problems are being dealt with by MOD and the Joint Program Office. Detailed claims made by *The Times* were systematically criticized in this submission, and Wing Commander James Beck, who is about to assume control of the United Kingdom's JSF Program, noted:

> The F-35 is the best aircraft I've ever flown. It is the most advanced multi-role fighter jet out there and the aircraft most suited to the UK's needs. With huge flexibility and cutting-edge innovation, this supersonic, stealth aircraft will bring about a generation change in the way we fight in the Combat Air arena for many decades to come.[55]

Conclusions and recommendations in the Commons Defence Committee report included:

1. Satisfaction that the Government acknowledges the potential value of using the Multifunction Advanced Data Link (MADL) for secure communications between the JSF and older aircraft.
2. Expanding the bandwidth of *Queen Elizabeth* carriers from 8 megabits to over 32 megabits.

3. Satisfaction that Lockheed Martin and MOD have been rigorously testing the ALIS software to rectify bugs and that British contractors have sufficient ALIS intellectual property rights.
4. Concern over the lack of MOD transparency on cost estimates and recommending that full unit costs such be provided for each aircraft once spares and upgrades are included.
5. Displeasure that cost figures were only sent to Conservative parliamentarians instead of MPs from all parties.
6. Requiring the government to provide six-month updates on program progress every six months including details on ongoing program costs including sustainment, spares, and logistics, software upgrades, and unit recurring flyaway costs. Future trials of communications between the JSF and older aircraft via MADL systems should be communicated by MOD to the Committee on progress made.[56]

RAF Squadron 617 is expected to declare JSF land Initial Operating Capability (IOC) with nine aircraft in December 2018. Operational Conversion Squadron 207 anticipates achieving IOC in 2019 and operational unit Naval Air Squadron 809 expects to achieve IOC in 2023. The year 2019 will also see the Tornado fighter leave operational service and Lightning squadrons will be based at RAF Marham.[57]

Conclusion

Britain's experience with the JSF has featured similar successes and failures to those experienced by other partner countries. It is highly likely that the JSF will gradually be incorporated into Britain's naval and airpower operations given the economic and political capital invested so far. This could change if there are unresolved spending and development problems with the JSF further delaying its production and deployment or if Jeremy Corbyn and Labor come to power in a future British election. However, Russia's increasing geopolitical aggressiveness in Europe and the Middle East and the continuing likelihood that Britain will need to engage in counterterrorism operations against Daesh and its allies in the Middle East and North Africa using air strikes make it highly probable that the JSF will be a critical component of British aerial and naval military strike power in the years to come.

The next chapter will look at the experiences of other US allied countries with the JSF and how it may be incorporated into their national security and military strategies.

Notes

1. See Louisa Brooke-Holland, *The UK's F-35 Lightning II Joint Strike Fighter* (London: House of Commons Library, 2015): 4; http://researchbriefings.files.parliament.uk/documents/SN06278/SN06278.pdf; accessed March 2, 2017; Jonathan Glancey, "Inside the F-35: The World's Most Futuristic Fighter Jet," *The Telegraph* (January 16, 2013); http://www.telegraph.co.uk/news/uknews/defence/9780450/Inside-the-F-35-the-futuristic-fighter-jet.html; accessed March 2, 2017 and Cynthia R. Cook et al., *Assembling and Supporting the Joint Strike Fighter in the UK* (Santa Monica: The Rand Corporation, 2003); http://www.rand.org/pubs/monograph_reports/MR1771.html; accessed March 6, 2017; Jeremy Stocker, *Britain's Role In U.S. Missile Defense* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2004); Terence R. Guay, *The Trans-Atlantic Defense Industrial Base: Restructuring Scenarios and Their Implications* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2005); Andrew M. Dorman, *Transforming to Effects-Based Operations: Lessons from the United Kingdom Experience* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2008); *Anglo-American Relations: Contemporary Perspectives*, Alan Dobson and Steve P. Marsh, eds. (London: Routledge, 2013); Deborah Haynes. "Britain Spends Billions on Flawed Fighter Jets; Setbacks and Hidden Charges Push Costs of Stealth Aircraft to £150 m Each," *Times of London* (July 17, 2017): 1–2; and Great Britain, Parliament, House of Commons, Defence Committee, *Unclear for Takeoff?:F-35 Procurement: Second Report of Session 2017–19* (London: HMSO, 2017): 23; https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/326/326.pdf; accessed June 7, 2018.
2. Trevor Taylor. "'Que Sera, Sera': The UK and the F-35," *RUSI Newsbrief*, 33 (2) (March 2013): 1–3; https://rusi.org/publication/newsbrief/%E2%80%98que-sera-sera%E2%80%99-uk-and-f-35; accessed March 2, 2017.
3. Great Britain, Parliament, House of Commons, *Hansard Parliamentary Debates*, 287 (Series 6) (December 10, 1996): c159W; http://hansard.millbanksystems.com/written_answers/1996/dec/10/joint-strike-fighter#S6CV0287P0_19961210_CWA_415; accessed March 6, 2017.

4. See Ibid., *Hansard*, 316 (Series 6) (July 21, 1998): c477w; http://hansard.millbanksystems.com/written_answers/1998/jul/21/joint-strike-fighter#S6CV0316P0_19980721_CWA_250; accessed March 6, 2017; Tom Dodd and Mark Oakes, *The Strategic Defense Review White Paper* (London: House of Commons Library, 1998): 36, 56; http://www.parliament.uk/briefing-papers/RP98-91/the-strategic-defence-review-white-paper; accessed March 16, 2017.
5. See Great Britain, Parliament, House of Commons, Defence Committee, *Future Carrier and Joint Combat Aircraft Programmes: Second Report of Session 2005–06* (London: HMSO, 2005): 24–25; http://www.publications.parliament.uk/pa/cm200506/cmselect/cmdfence/554/554.pdf; accessed March 6, 2017; and Brooke-Holland, *The UK's F-35 Lightning II Joint Strike Fighter* (London: House of Commons Library, 2015): 3.
6. See Ibid. (London: HMSO, 2005): 3; D.A. Deptula, "Air Force Transformation Past, Present, & Future," *Air Power Review*, 5 (1) (Spring 2002): 22; http://www.airpowerstudies.co.uk/sitebuildercontent/sitebuilderfiles/aprvol5no1.pdf; accessed March 16, 2017; and Claire Taylor. *UK Defence Procurement Policy* (London: House of Commons Library, 2003): 27; http://www.parliament.uk/briefing-papers/RP03-78/uk-defence-procurement-policy; accessed March 16, 2017.
7. *Future Carrier and Joint Combat Aircraft Programmes*, 3, 29–31; and Great Britain, National Audit Office, *Ministry of Defence Major Projects Report 2013: Appendices and Project Summary Sheets* (London: NAO, 2014): 105–107; http://www.nao.org.uk/wp-content/uploads/2015/02/Major-Projects-Appendicies-and-project-summary-sheets.pdf; accessed March 16, 2017.
8. See Ibid. (London: NAO, 2014): 105–106; http://www.nao.org.uk/wp-content/uploads/2015/02/Major-Projects-Appendicies-and-project-summary-sheets.pdf; accessed March 12, 2017, and *Future Carrier and Joint Combat Aircraft Programmes*, 25, 31.
9. Great Britain, Ministry of Defence, *Annual Report and Accounts 2006–2007* (London: MOD, 2007): 99; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228772/0697.pdf; accessed March 16, 2017.
10. See Francis Harris, "Computer Codes Row Threatens Pounds 12bn Jet Order," *The Daily Telegraph* (March 15, 2006): 13; "F-35 JSF Program: U.S. & UK Reach Technology Transfer Agreement," *Defense Industry Daily* (August 4, 2006); http://www.defenseindustrydaily.com/f35-jsf-program-us-uk-reach-technology-transfer-agreement-02495/; accessed March 10, 2017; U.S. Department of State, *Defense Communications: Memorandum of Understanding Between the United States of America and the United Kingdom of Great Britain and Northern Ireland Signed at Corsham and Offutt AFB March 16 and May 9, 2007 with Annex and*

Agreement Amending the Memorandum of Understanding Signed at Abbey Wood and Offutt AFB, December 4, 2007 and January 18, 2008 (Washington, DC: Department of State, 2013); http://permanent.access.gpo.gov/gpo36384/183520.pdf; accessed March 6, 2017; and Peter Ito, David M. Moore, Stuart Young, Kevin Burgess, and Peter Antill, "Impact of U.S. Export Control and Technology Transfer Regime on the Joint Strike Fighter (JSF) Project: Views of Key UK Stakeholders," *International Journal of Defense Acquisition Management*, 4 (2011): 1–52.

11. Antill and Ito, "The UK and the Joint Strike Fighter," *International Journal* 68 (1) (Winter 2012–13): 19.
12. Great Britain, Parliament, House of Commons, Defence Select Committee, *Defence Equipment 2008: Tenth Report of Session 2007–08* (London: HMSO, 2008): 4, 52–53, EV 17; http://www.publications.parliament.uk/pa/cm200708/cmselect/cmdfence/295/295.pdf; accessed March 10, 2017. View O'Donoghue's and Gould's responses to questioning at http://www.parliamentlive.tv/Event/Index/8a7890e3-5800-4e7b-8463-20e89a617d07; 10:33:44–12:59:00; accessed March 2, 2017.
13. Ibid., *Defence Equipment 2008: Government Response to the Committee's Tenth Report of Session 2007–08* (London: HMSO, 2008): 9; http://www.publications.parliament.uk/pa/cm200708/cmselect/cmdfence/555/555.pdf; accessed March 10, 2017.
14. See Brooke-Holland (2015): 17; and NAO, *Ministry of Defence Major Projects Report 2013*, 105–106.
15. See Great Britain, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review* (London: HM Government, 2010): 3, 5, 23, 26; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/62482/strategic-defence-security-review.pdf; accessed March 6, 2017; Great Britain, Parliament, House of Commons, *Hansard*, 516 (54) (October 19, 2010): columns 797–801; https://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101019/debtext/101019-0001.htm#10101928000003; accessed March 2, 2017 and Cameron's remarks can be viewed at http://www.parliamentlive.tv/Event/Index/3e84e39c-420b-43b1-a3af-5d97ac1e46cf; 15:32:14–15:49:30; accessed March 2, 2017.
16. See Great Britain, Parliament, House of Commons, Committee of Public Accounts, *Report by the Comptroller and Auditor General: Ministry of Defence: Carrier Strike (HC 1092)* (London: TSO, 2011); EV 3; http://www.publications.parliament.uk/pa/cm201012/cmselect/cmpubacc/1427/1427.pdf; accessed March 9, 2017; and view this exchange at the British Parliament's Parliamentlive.tv service http://www.parliamentlive.tv/Event/Index/914e86b6-ac51-47c7-8800-185969b36bc0; 16:22:02–16:23:37; accessed March 2, 2017.
17. See Ibid., EV 3; and Ibid., 16:18:37–16:18:50.

18. Ibid., EV 5.
19. See Brooke-Holland (2015): 8; Thomas Harding, "Costs of Refitting Royal Navy Aircraft Carrier Trebles," *Daily Telegraph* (March 12, 2012): http://www.telegraph.co.uk/news/uknews/defence/9139029/Cost-of-refitting-Royal-Navy-aircraft-carrier-trebles.html; accessed March 11, 2017 and National Audit Office, *Ministry of Defence: Carrier Strike* (London: NAO, 2011); http://www.nao.org.uk/wp-content/uploads/2011/07/10121092.pdf; accessed March 11, 2017.
20. Antill and Ito, *International Journal*, 22.
21. See Brooke-Holland (2015): 8–9; and *Hansard*, 545 (2) (May 10, 2012): Columns 140–142; https://www.publications.parliament.uk/pa/cm201213/cmhansrd/cm120510/debtext/120510-0001.htm#12051029000006; accessed March 3, 2017; Audio webcast at http://www.parliamentlive.tv/Event/Index/ac963c45-b036-42da-9137-9bbc2b330d9a; 11:11:18–11:22:38; accessed March 11, 2017.
22. See Ibid., Column 143; Audio webcast at Ibid., 11:22:43–11:28:34; Brooke-Holland, 9; and Christopher Parry, The United Kingdom's Future Carriers: What Are They Good For?," *RUSI Journal*, 157 (6) (December 2012): 4–9.
23. *Hansard Parliamentary Debates Commons*, 575, no. 118 (February 5, 2014): C242w-C243w; http://www.publications.parliament.uk/pa/cm201314/cmhansrd/cm140205/text/140205w0001.htm#14020589000058; accessed March 6, 2017.
24. National Audit Office, *Ministry of Defence Carrier Strike 2012 Reversion Decision* (London: NAO, 2013): 6–9, 11; http://www.nao.org.uk/wp-content/uploads/2013/05/10149-001-Carrier.full-report.pdf; accessed March 6, 2017.
25. See Brooke-Holland (2015): 17; and National Audit Office, *Major Projects Report 2014 and the Equipment Plan 2014–2024* (London: NAO, 2015): 18, 42; http://www.nao.org.uk/wp-content/uploads/2015/01/Major-projects-report-2014-and-the-equipment-plan-2014-to-20151.pdf; accessed March 6, 2017.
26. See Simon Mitchell, "F-35—Getting the UK's Largest Defence Opportunity on Track," *RUSI Defence System*, 15 (1) (July 2012): 60–61; and Lockheed Martin, *United Kingdom Industrial Participation: Built in the United Kingdom, Delivered to the World*" (Fort Worth: Lockheed Martin, 2017): 1; https://www.f35.com/global/participation/united-kingdom-ip; accessed March 6, 2017.
27. See Great Britain, Ministry of Defence, *Delivering Growth: Implementing the Strategic Vision for the UK Defence Sector* (London: MOD, 2014): 13, 42; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/329781/bis-14-953-defence-growth-partnership-deliv-

ering-growth-implementing-the-strategic-vision-for-the-uk-defence-sector.pdf; accessed March 16, 2017; Great Britain, Department for International Trade, *Open General Export License: Exports in Support of Joint Strike Fighter (F-35 Lightning II)* (London: Department for International Trade, 2018): 5; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464629/15-234-ogel-joint-strike.pdf; accessed June 7, 2018; and Louisa Brooke-Holland, *Prospects for Combat Air: What Follows Typhoon and Lightning?* (London: House of Commons Library, 2018): 10; http://researchbriefings.files.parliament.uk/documents/CBP-8304/CBP-8304.pdf; accessed June 7, 2018.

28. See Great Britain, Office of the Secretary of State for Wales, "Welsh Secretary visits DECA, the North Wales Home of the Global F-35 hub as UK's Industrial Strategy Announced" (London: Office of the Secretary of State for Wales, January 25, 2017): 1–2; https://www.gov.uk/government/news/welsh-secretary-visits-deca-the-north-wales-home-of-the-global-f-35-hub-as-uks-industrial-strategy-announced; accessed March 7, 2017; and Ministry of Defence, Defence Equipment and Support, "UK Chosen as a Global F-35 Repair Hub" (London: MOD, November 7, 2016): 1–2; https://www.gov.uk/government/news/uk-chosen-as-a-global-f-35-repair-hub; accessed March 7, 2017.
29. See Brooke-Holland (2015): 19; and House of Commons, Defence Select Committee, *Future Force 2020* (London: Defence Select Committee, 2014): 12; http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/rethinking-defence-to-meet-new-threats/oral/16882.pdf; accessed March 6, 2017; webcast at http://www.parliamentlive.tv/Event/Index/0c5751a5-d61b-46eb-b271-d48259e2205d; 14:46:16–16:20; accessed March 6, 2017.
30. Great Britain, Electoral Commission, *2015 UK General Election Results* (London: Electoral Commission, 2016): 1–2; http://www.electoralcommission.org.uk/find-information-by-subject/elections-and-referendums/past-elections-and-referendums/uk-general-elections/2015-uk-general-election-results; accessed March 6, 2017.
31. See Great Britain, Office of National Statistics, *Defence-Related Activities in the UK* (London: ONS, September 8, 2014): http://www.ons.gov.uk/ons/rel/prodcom/prodcom-final-results/defence-related-activities-in-the-uk/sty-def.html; accessed March 6, 2017; Ministry of Defence, *Defence in Numbers* (London: MOD, September 2016): 2. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561135/UK_Defence_in_Numbers_2016-revised.pdf; accessed March 6, 2017; *UK Defence in* Numbers (London: MOD, September

2017): 2; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652915/UK_Defence_in_Numbers_2017_-_Update_17_Oct.pdf; accessed January 3, 2018; and Christopher Chantrill, *Public Spending Details for 2017*, https://www.ukpublicspending.co.uk/uk_year2017_0.html; accessed June 8, 2019.
32. Great Britain, Parliament, *Early Day Motion 757: Defence Spending* (London: House of Commons, February 3, 2015); http://www.parliament.uk/edm/2014-15/757; accessed March 12, 2017.
33. *Hansard Parliamentary Debates Commons*, 594 (124) (March 12, 2015): Cols. 429, 432, 487; http://www.publications.parliament.uk/pa/cm201415/cmhansrd/cm150312/debtext/150312-0002.htm#15031223000001; accessed March 6, 2017; Webcast at http://www.parliamentlive.tv/Event/Index/fe9e4868-f7e2-47d8-96c7-50b7f12399de; 9:34 to 17:52; accessed March 6, 2017.
34. Ibid., Cols. 437, 444.
35. See Ben Jones, "UK SDSR: Same Ends, Less Means, New Ways?," *European Geostrategy* (November 5, 2014): http://www.css.ethz.ch/en/services/digital-library/articles/article.html/185518/pdf; accessed January 3, 2018; and Ben Riley-Smith and Ben Farmer, "RAF Jets Scrambled More Than 40 Times to Intercept Russian Bombers," *Daily Telegraph* (February 21, 2015); http://www.telegraph.co.uk/news/uknews/defence/11426692/RAF-jets-scrambled-more-than-40-times-to-intercept-Russian-bombers.html; accessed March 12, 2017.
36. George Grant, *In Scotland's Defence?: An Assessment of SNP Defence Strategy* (London: The Henry Jackson Society, 2013): 101; http://henryjacksonsociety.org/wp-content/uploads/2013/07/HJS-In-Scotlands-Defence-Report-LOW-RES.pdf; accessed March 6, 2017.
37. See Great Britain, *A National Security Strategy and Strategic and Defense Security Review: A Secure and Prosperous United Kingdom* (London: Prime Minister, 2015): 6, 29–31; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/555607/2015_Strategic_Defence_and_Security_Review.pdf; accessed March 6, 2017; Bert Chapman "Geopolitics of the 2015 British Defense White Paper and Its Historical Predecessors," *Geopolitics, History, and International Relations*, 8 (2, 2016): 42–63; http://docs.lib.purdue.edu/lib_fsdocs/128/; accessed March 6, 2017; *Hansard Parliamentary Debates Commons* 602 (74) (November 23, 2015): Col. 1070; https://hansard.parliament.uk/commons/2015-11-23/debates/15112320000002/NationalSecurityAndDefence; Webcast at https://www.parliamentlive.tv/Event/Index/6d6630c1-efe8-4cbc-8c58-d61dd4d02707. 16:45:30–16:46:01; accessed March 7, 2017.

38. Great Britain, Ministry of Defence, "MOD Signs £184 million Contract to Secure Air-to-Air Missiles for the F-35B" (London: MOD, August 16, 2016): 1–2; https://www.gov.uk/government/news/mod-signs-184-million-contract-to-secure-air-to-air-missiles-for-the-f-35; accessed March 7, 2017.
39. Great Britain, The Electoral Commission, "EU Referendum Results" (London: The Electoral Commission, 2016): 1; http://www.electoral-commission.org.uk/find-information-by-subject/elections-and-referendums/past-elections-and-referendums/eu-referendum/electorate-and-count-information; accessed March 7, 2017.
40. *Hansard Parliamentary Debates: Commons*, 597 (27) (July 2, 2015): Col. 1729; https://hansard.parliament.uk/Commons/2015-07-02/debates/15070233000001/BritainAndInternationalSecurity?highlight=joint%20strike%20fighter#contribution-15070238000301; Webcast at http://www.parliamentlive.tv/Event/Index/8315f42e-dc7a-485c-ac7f-21de8032e9ba; 16:26:43–16:33:15; accessed March 7, 2017.
41. Ibid., 620 (104) (February 2, 2017): Col. 1286; https://hansard.parliament.uk/Commons/2017-02-02/debates/72F1C37B-0E33-412C-9B04-46079901610E/ArmedForcesCovenant?highlight=joint%20strike%20fighter#contribution-B82E9196-5EE7-484F-8522-FC3BEDE68FD2; accessed March 7, 2017.
42. Great Britain, Parliament, Commons Defence Committee, *Shifting the Goalposts? Defence Expenditure and the 2% Pledge: Second Report of Session 2015–16* (London: TSO, 2016): 30; http://www.publications.parliament.uk/pa/cm201516/cmselect/cmdfence/494/494.pdf; accessed March 7, 2017.
43. Ibid.
44. Ibid., *Russia: Implications for UK Defence and Security: First Report of Session 2016–17* (London, TSO, 2016): 24–25, 27–28, 50; http://www.publications.parliament.uk/pa/cm201617/cmselect/cmdfence/107/107.pdf; accessed March 7, 2017.
45. Ibid., *Oral Evidence: Defence Acquisition and Procurement, HC 698* (London: TSO, January 31, 2017): Q294–295; http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/defence-acquisition-and-procurement/oral/46546.pdf; accessed March 7, 2017. Webcast at http://parliamentlive.tv/Event/Index/5b6465b9-f147-44b5-b5b5-51d7dda76722; 12:48:20–12:54:06; accessed March 7, 2017.
46. National Audit Office, *Ministry of Defence: Major Projects Report 2015 and the Equipment Plan 2015 to 2025* (London: NAO, 2015): 22, 42, 55; https://www.nao.org.uk/wp-content/uploads/2015/10/Major-Projects-Report-2015-and-the-Equipment-Plan-2015-2025.pdf; accessed March 7, 2017.

47. Ibid., *Impact of the Strategic Defence and Security Review on the Equipment Plan* (London: NAO, 2016): 5, 13; https://www.nao.org.uk/wp-content/uploads/2016/06/Impact-of-the-Strategic-Defence-and-Security-Review-on-the-Equipment-Plan.pdf; accessed March 7, 2017.
48. See Ibid., *Ministry of Defence: The Equipment Plan 2016 to 2026* (London: NAO, 2017): 4, 42; https://www.nao.org.uk/wp-content/uploads/2017/01/The-Equipment-Plan-2016-2026.pdf; accessed March 8, 2017; and Christopher Hope, "MoD Told to Find £6 Bn in Extra Savings or New Tanks and Planes Will be at Risk," *The Daily Telegraph* (January 28, 2017): 6.
49. See Great Britain, Her Majesty's Treasury, "Oral statement to Parliament Spring Budget 2017: Philip Hammond's Speech" (London: HM Treasury, March 8, 2017): 1–18; https://www.gov.uk/government/speeches/spring-budget-2017-philip-hammonds-speech; accessed March 8, 2017; webcast at http://www.parliamentlive.tv/Event/Index/8a000060-1bde-4491-bffe-4359e85832ea; 12:35:46–13:33:04; accessed March 8, 2017; Ibid., *Spring Budget 2017, HC 1025* (London: HM Treasury, March 8, 2017); 4; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/597467/spring_budget_2017_web.pdf; accessed March 8, 2017; Steve Richards, "Leadership, Loyalty, and the Rise of Jeremy Corbyn," *The Political Quarterly*, 87 (1, January–March, 2016): 12–17; https://doi.org/10.1111/1467-923X.12221; and Fraser Nelson, "The Evolution of Theresa May Will Give Britain a Bright Global Future; The PM has Quietly Grown into the Job, Abandoning her Mean, Narrow Vision of Brexit for a Positive Agenda," *The Daily Telegraph* (January 20, 2017): 16.
50. See Great Britain, The Electoral Commission, "2017 UK General Election Results" (London: The Electoral Commission, 2017): 1; https://www.electoralcommission.org.uk/our-work/our-research/electoral-data/2017-uk-general-election-results; accessed January 3, 2018; and Alex Hunt, "Theresa May and the DUP Deal: What You Need to Know," *BBC News* (June 26, 2017): 1–5; http://www.bbc.com/news/election-2017-40245514; accessed January 3, 2018.
51. Haynes, 1–2.
52. *Unclear for Take-Off?: F-35 Procurement* (London: TSO, 2017), 35–37; https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/326/326.pdf; accessed January 3, 2018.
53. Ibid., 22–25.
54. "Written Evidence Submitted by Lockheed Martin" (London: TSO, 2017): 1–13; http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/unclear-for-takeoff-f35-procurement/written/73296.pdf; accessed January 3, 2018.

55. “Written Evidence Submitted by the Ministry of Defence” (London, TSO, 2017): 9–11; http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/unclear-for-takeoff-f35-procurement/written/74078.pdf; accessed January 3, 2018.
56. *Unclear for Take-Off?: F-35 Procurement*, 32–34.
57. Brooke-Holland (2018): 13–14.

References

Antill, Peter, and Peter Ito. “The UK and the Joint Strike Fighter.” *International Journal*, 68 (1) (Winter 2012–13): 19.

Brooke-Holland, Louisa. *The UK's F-35 Lightning II Joint Strike Fighter* (London: House of Commons Library, 2015): 4. http://researchbriefings.files.parliament.uk/documents/SN06278/SN06278.pdf. Accessed March 2, 2017.

———. *Prospects for Combat Air: What Follows Typhoon and Lightning?* (London: House of Commons Library, 2018): 10. http://researchbriefings.files.parliament.uk/documents/CBP-8304/CBP-8304.pdf. Accessed June 7, 2018.

Chantrill, Christopher. *Public Spending Details for* 2017. https://www.ukpublicspending.co.uk/uk_year2017_0.html. Accessed June 8, 2019.

Chapman, Bert. “Geopolitics of the 2015 British Defense White Paper and Its Historical Predecessors.” *Geopolitics, History, and International Relations*, 8 (2) (2016): 42–63. http://docs.lib.purdue.edu/lib_fsdocs/128/. Accessed March 6, 2017.

Cook, Cynthia R. et al. *Assembling and Supporting the Joint Strike Fighter in the UK* (Santa Monica: The Rand Corporation, 2003). http://www.rand.org/pubs/monograph_reports/MR1771.html. Accessed March 6, 2017.

Deptula, D.A. “Air Force Transformation Past, Present, & Future.” *Air Power Review*, 5 (1) (Spring 2002): 22. http://www.airpowerstudies.co.uk/sitebuildercontent/sitebuilderfiles/aprvol5no1.pdf. Accessed March 16, 2017.

Dobson, Alan, and Steve P. Marsh, eds. *Anglo-American Relations: Contemporary Perspectives* (London: Routledge, 2013).

Dodd, Tom, and Mark Oakes. *The Strategic Defense Review White Paper* (London: House of Commons Library, 1998): 36, 56. http://www.parliament.uk/briefing-papers/RP98-91/the-strategic-defence-review-white-paper. Accessed March 16, 2017.

Dorman, Andrew M. *Transforming to Effects-Based Operations: Lessons from the United Kingdom Experience* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2008).

“F-35 JSF Program: U.S. & UK Reach Technology Transfer Agreement.” *Defense Industry Daily* (August 4, 2006). http://www.defenseindustrydaily.com/f35-jsf-program-us-uk-reach-technology-transfer-agreement-02495/. Accessed March 10, 2017.

Glancey, Jonathan. "Inside the F-35: The World's Most Futuristic Fighter Jet." *The Telegraph* (January 16, 2013). http://www.telegraph.co.uk/news/uknews/defence/9780450/Inside-the-F-35-the-futuristic-fighter-jet.html. Accessed March 2, 2017.

Grant, George. *In Scotland's Defence?: An Assessment of SNP Defence Strategy* (London: The Henry Jackson Society, 2013): 101. http://henryjacksonsociety.org/wp-content/uploads/2013/07/HJS-In-Scotlands-Defence-Report-LOW-RES.pdf. Accessed March 6, 2017.

Great Britain. *Defence Equipment 2008: Tenth Report of Session 2007–08* (London: HMSO, 2008): 4, 52–53, EV 17. http://www.publications.parliament.uk/pa/cm200708/cmselect/cmdfence/295/295.pdf. Accessed March 10, 2017. View O'Donoghue's and Gould's responses to questioning at http://www.parliamentlive.tv/Event/Index/8a7890e3-5800-4e7b-8463-20e89a617d07. 10:33:44–12:59:00. Accessed March 2, 2017.

———. *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review* (London: H.M. Government, 2010). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/62482/strategic-defence-security-review.pdf. Accessed March 6, 2017.

———. *Ministry of Defence: Carrier Strike* (London: NAO, 2011). http://www.nao.org.uk/wp-content/uploads/2011/07/10121092.pdf. Accessed March 11, 2017.

———. *Ministry of Defence Carrier Strike 2012 Reversion Decision* (London: NAO, 2013): 6–9, 11. http://www.nao.org.uk/wp-content/uploads/2013/05/10149-001-Carrier.full-report.pdf. Accessed March 6, 2017.

———. *Ministry of Defence Major Projects Report 2013: Appendices and Project Summary Sheets* (London: NAO, 2014a): 105–107. http://www.nao.org.uk/wp-content/uploads/2015/02/Major-Projects-Appendicies-and-project-summary-sheets.pdf. Accessed March 16, 2017.

———. *Future Force 2020* (London: Defence Select Committee, 2014b): 12. http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/rethinking-defence-to-meet-new-threats/oral/16882.pdf. Accessed March 6, 2017. Webcast at http://www.parliamentlive.tv/Event/Index/0c5751a5-d61b-46eb-b271-d48259e2205d. 14:46:16–16:20. Accessed March 6, 2017.

———. *A National Security Strategy and Strategic and Defense Security Review: A Secure and Prosperous United Kingdom* (London: Prime Minister, 2015a): 6, 29–31. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/555607/2015_Strategic_Defence_and_Security_Review.pdf. Accessed March 6, 2017.

———. *Major Projects Report 2014 and the Equipment Plan 2014–2024* (London: NAO, 2015b): 18, 42. http://www.nao.org.uk/wp-content/uploads/2015/01/Major-projects-report-2014-and-the-equipment-plan-2014-to-20151.pdf. Accessed March 6, 2017.

———. *Ministry of Defence: Major Projects Report 2015 and the Equipment Plan 2015 to 2025* (London: NAO, 2015c): 22, 42, 55. https://www.nao.org.uk/wp-content/uploads/2015/10/Major-Projects-Report-2015-and-the-Equipment-Plan-2015-2025.pdf. Accessed March 7, 2017.

———. *Russia: Implications for UK Defence and Security: First Report of Session 2016–17* (London: TSO, 2016a): 24–25, 27–28, 50. http://www.publications.parliament.uk/pa/cm201617/cmselect/cmdfence/107/107.pdf. Accessed March 7, 2017.

———. *Shifting the Goalposts? Defence Expenditure and the 2% Pledge: Second Report of Session 2015–16* (London: TSO, 2016b): 30. http://www.publications.parliament.uk/pa/cm201516/cmselect/cmdfence/494/494.pdf. Accessed March 7, 2017.

———. *Ministry of Defence: The Equipment Plan 2016 to 2026* (London: NAO, 2017a): 4, 42. https://www.nao.org.uk/wp-content/uploads/2017/01/The-Equipment-Plan-2016-2026.pdf.Accessed March 8, 2017.

———. *Oral Evidence: Defence Acquisition and Procurement, HC 698* (London: TSO, January 31, 2017b): Q294–295. http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/defence-acquisition-and-procurement/oral/46546.pdf. Accessed March 7, 2017. Webcast at http://parliamentlive.tv/Event/Index/5b6465b9-f147-44b5-b5b5-51d7dda76722. 12:48:20–12:54:06. Accessed March 7, 2017.

———. *Unclear for Take-Off?: F-35 Procurement* (London: TSO, 2017c): 35–37. https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/326/326.pdf. Accessed January 3, 2018.

———. *Written Evidence Submitted by Lockheed Martin* (London: TSO, 2017d): 1–13. http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/unclear-for-takeoff-f35-procurement/written/73296.pdf. Accessed January 3, 2018.

———. *Written Evidence Submitted by the Ministry of Defence* (London, TSO, 2017e): 9–11. http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/defence-committee/unclear-for-takeoff-f35-procurement/written/74078.pdf. Accessed January 3, 2018.

Great Britain. Department for International Trade. *Open General Export License: Exports in Support of Joint Strike Fighter (F-35 Lightning II)* (London: Department for International Trade, 2018): 5. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/699595/18-ogel-joint-strike.pdf. Accessed March 7, 2017.

Great Britain. Her Majesty's Treasury. *Oral statement to Parliament Spring Budget 2017: Philip Hammond's Speech* (London: HM Treasury, March 8, 2017a): 1–18. https://www.gov.uk/government/speeches/spring-budget-2017-philip-hammonds-speech. Accessed March 8, 2017. Webcast at http://www.parliamentlive.tv/Event/Index/8a000060-1bde-4491-bffe-4359e85832ea. 12:35:46–13:33:04. Accessed March 8, 2017.

———. *Spring Budget 2017, HC 1025* (London: HM Treasury, March 8, 2017b): 4. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/597467/spring_budget_2017_web.pdf. Accessed March 8, 2017.

Great Britain. Ministry of Defence. *Annual Report and Accounts 2006–2007* (London: MOD, 2007): 99. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228772/0697.pdf. Accessed March 16, 2017.

———. *Delivering Growth: Implementing the Strategic Vision for the UK Defence Sector* (London: MOD, 2014): 13, 42. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/329781/bis-14-953-defence-growth-partnership-delivering-growth-implementing-the-strategic-vision-for-the-uk-defence-sector.pdf. Accessed March 16, 2017.

———. *Defence in Numbers* (London: MOD, September 2016a): 2. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561135/UK_Defence_in_Numbers_2016-revised.pdf. Accessed March 6, 2017.

———. *MOD Signs £184 million Contract to Secure Air-to-Air Missiles for the F-35B* (London: MOD, August 16, 2016b): 1–2. https://www.gov.uk/government/news/mod-signs-184-million-contract-to-secure-air-to-air-missiles-for-the-f-35. Accessed March 7, 2017.

———. *UK Chosen as a Global F-35 Repair. Hub* (London: MOD, November 7, 2016c): 1–2. https://www.gov.uk/government/news/uk-chosen-as-a-global-f-35-repair-hub. Accessed March 7, 2017.

———. *UK Defence in Numbers* (London: MOD, September 2017, 2). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652915/UK_Defence_in_Numbers_2017_-_Update_17_Oct.pdf. Accessed January 3, 2018.

Great Britain. National Audit Office. *Impact of the Strategic Defence and Security Review on the Equipment Plan* (London: NAO, 2016): 5, 13. https://www.nao.org.uk/wp-content/uploads/2016/06/Impact-of-the-Strategic-Defence-and-Security-Review-on-the-Equipment-Plan.pdf. Accessed March 7, 2017.

Great Britain. Office of National Statistics. *Defence-Related Activities in the UK* (London: ONS, September 8, 2014). http://www.ons.gov.uk/ons/rel/prodcom/prodcom-final-results/defence-related-activities-in-the-uk/sty-def.html. Accessed March 6, 2017.

Great Britain. Office of the Secretary of State for Wales. *Welsh Secretary Visits DECA, the North Wales Home of the Global F-35 Hub as UK's Industrial Strategy Announced* (London: Office of the Secretary of State for Wales, January 25, 2017): 1–2. https://www.gov.uk/government/news/welsh-secretary-visits-deca-the-north-wales-home-of-the-global-f-35-hub-as-uks-industrial-strategy-announced. Accessed March 7, 2017.

Great Britain. Parliament. *Early Day Motion 757: Defence Spending* (London: House of Commons, February 3, 2015). http://www.parliament.uk/edm/2014-15/757. Accessed March 12, 2017.

Great Britain. Parliament. House of Commons. *Hansard Parliamentary Debates*, 287 (Series 6) (December 10, 1996): c159W. http://hansard.millbanksystems.com/written_answers/1996/dec/10/joint-strike-fighter#S6CV0287P0_19961210_CWA_415. Accessed March 6, 2017.

———. *Hansard Parliamentary Debates*, 316 (Series 6) (July 21, 1998): c477w. http://hansard.millbanksystems.com/written_answers/1998/jul/21/joint-strike-fighter#S6CV0316P0_19980721_CWA_250. Accessed March 6, 2017.

———. *Hansard Parliamentary Debates*, 516 (54) (October 19, 2010): Columns 797–801. https://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101019/debtext/101019-0001.htm#10101928000003. Accessed March 2, 2017. Cameron's remarks can be viewed at http://www.parliamentlive.tv/Event/Index/3e84e39c-420b-43b1-a3af-5d97ac1e46cf. 15:32:14–15:49:30. Accessed March 2, 2017.

———. *Hansard Parliamentary Debates*, 545 (2) (May 10, 2012): Columns 140–142. https://www.publications.parliament.uk/pa/cm201213/cmhansrd/cm120510/debtext/120510-0001.htm#12051029000006. Accessed March 3, 2017. Audio webcast at http://www.parliamentlive.tv/Event/Index/ac963c45-b036-42da-9137-9bbc2b330d9a. 11:11:18–11:22:38. Accessed March 11, 2017.

———. *Hansard Parliamentary Debates*, 575 (118) (February 5, 2014): C242w–C243w. http://www.publications.parliament.uk/pa/cm201314/cmhansrd/cm140205/text/140205w0001.htm#14020589000058. Accessed March 6, 2017.

———. *Hansard Parliamentary Debates*, 594 (124) (March 12, 2015a): Columns 429, 432, 487. http://www.publications.parliament.uk/pa/cm201415/cmhansrd/cm150312/debtext/150312-0002.htm#15031223000001. Accessed March 6, 2017. Webcast at http://www.parliamentlive.tv/Event/Index/fe9e4868-f7e2-47d8-96c7-50b7f12399de. 9:34 to 17:52. Accessed March 6, 2017.

———. *Hansard Parliamentary Debates*, 597 (27) (July 2, 2015b): Column 1729. https://hansard.parliament.uk/Commons/2015-07-02/debates/15070233000001/BritainAndInternationalSecurity?highlight=joint%20strike%20fighter#contribution-15070238000301. Webcast at http://www.parliamentlive.tv/Event/Index/8315f42e-dc7a-485c-ac7f-21de8032e9ba. 16:26:43–16:33:15. Accessed March 7, 2017.

———. *Hansard Parliamentary Debates*, 602 (74) (November 23, 2015c): Column 1070. https://hansard.parliament.uk/commons/2015-11-23/debates/1511232000002/NationalSecurityAndDefence. Webcast at https://

www.parliamentlive.tv/Event/Index/6d6630c1-efe8-4cbc-8c58-d61dd4d02707. 16:45:30–16:46:01. Accessed March 7, 2017.

———. *Hansard Parliamentary Debates*, 620 (104) (February 2, 2017): Column 1286. https://hansard.parliament.uk/Commons/2017-02-02/debates/72F1C37B-0E33-412C-9B04-46079901610E/ArmedForcesCovenant?highlight=joint%20strike%20fighter#contribution-B82E9196-5EE7-484F-8522-FC3BEDE68FD2. Accessed March 7, 2017.

Great Britain. Parliament. House of Commons. Committee of Public Accounts. *Report by the Comptroller and the Auditor General: Ministry of Defence: Carrier Strike (HC 1092)* (London: TSO, 2011): EV 3. http://www.publications.parliament.uk/pa/cm201012/cmselect/cmpubacc/1427/1427.pdf. Accessed March 9, 2017. Video at http://www.parliamentlive.tv/Event/Index/914e86b6-ac51-47c7-8800-185969b36bc0. 16:22:02–16:23:37. Accessed March 2, 2017.

Great Britain. Parliament. House of Commons. Defence Committee. *Future Carrier and Joint Combat Aircraft Programmes: Second Report of Session 2005–06* (London: HMSO, 2005): 24–25. http://www.publications.parliament.uk/pa/cm200506/cmselect/cmdfence/554/554.pdf. Accessed March 6, 2017.

Great Britain. Parliament. House of Commons. Defense Select Committee. *Defence Equipment 2008: Government Response to the Committee's Tenth Report of Session 2007–08* (London: HMSO, 2008): 9. http://www.publications.parliament.uk/pa/cm200708/cmselect/cmdfence/555/555.pdf. Accessed March 10, 2017.

Great Britain. The Electoral Commission. *EU Referendum Results* (London: The Electoral Commission, 2016a): 1. http://www.electoralcommission.org.uk/find-information-by-subject/elections-and-referendums/past-elections-and-referendums/eu-referendum/electorate-and-count-information. Accessed March 7, 2017.

———. *2015 UK General Election Results* (London: Electoral Commission, 2016b): 1–2. http://www.electoralcommission.org.uk/find-information-by-subject/elections-and-referendums/past-elections-and-referendums/uk-general-elections/2015-uk-general-election-results. Accessed March 6, 2017.

———. *2017 UK General Election Results* (London: The Electoral Commission, 2017): 1. https://www.electoralcommission.org.uk/our-work/our-research/electoral-data/2017-uk-general-election-results. Accessed January 3, 2018.

Guay, Terence R. *The Trans-Atlantic Defense Industrial Base: Restructuring Scenarios and Their Implications* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2005).

Harding, Thomas. "Costs of Refitting Royal Navy Aircraft Carrier Trebles." *Daily Telegraph* (March 12, 2012). http://www.telegraph.co.uk/news/uknews/

defence/9139029/Cost-of-refitting-Royal-Navy-aircraft-carrier-trebles.html. Accessed March 11, 2017.

Harris, Francis. "Computer Codes Row Threatens 12bn Jet Order." *The Daily Telegraph* (March 15, 2006): 13.

Haynes, Deborah. "Britain Spends Billions on Flawed Fighter Jets; Setbacks and Hidden Charges Push Costs of Stealth Aircraft to £150m Each." *Times of London* (July 17, 2017): 1–2.

Hope, Christopher. "MoD Told to Find £6 Bn in Extra Savings or New Tanks and Planes Will Be at Risk." *The Daily Telegraph* (January 28, 2017): 6.

Hunt, Alex. "Theresa May and the DUP Deal: What You Need to Know." *BBC New* (June 26, 2017): 1–5. http://www.bbc.com/news/election-2017-40245514. Accessed January 3, 2018.

Ito, Peter, David M. Moore, Stuart Young, Kevin Burgess, and Peter Antill. "Impact of U.S. Export Control and Technology Transfer Regime on the Joint Strike Fighter (JSF) Project: Views of Key UK Stakeholders." *International Journal of Defense Acquisition Management*, 4 (2011): 1–52.

Jones, Ben. "UK SDSR: Same Ends, Less Means, New Ways?" *European Geostrategy* (November 5, 2014). http://www.css.ethz.ch/en/services/digital-library/articles/article.html/185518/pdf. Accessed January 3, 2018.

Lockheed Martin. *United Kingdom Industrial Participation: Built in the United Kingdom, Delivered to the World* (Fort Worth: Lockheed Martin, 2017): 1. https://www.f35.com/global/participation/united-kingdom-ip. Accessed March 6, 2017.

Mitchell, Simon. "F-35—Getting the UK's Largest Defence Opportunity on Track." *RUSI Defence System*, 15 (1) (July 2012): 60–61.

Nelson, Fraser. "The Evolution of Theresa May Will Give Britain a Bright Global Future: The PM Has Quietly Grown into the Job, Abandoning Her Mean, Narrow Vision of Brexit for a Positive Agenda." *The Daily Telegraph* (January 20, 2017): 16.

Parry, Christopher. "The United Kingdom's Future Carriers: What Are They Good For?" *RUSI Journal*, 157 (6) (December 2012): 4–9.

Richards, Steve. "Leadership, Loyalty, and the Rise of Jeremy Corbyn." *The Political Quarterly*, 87 (1) (January–March 2016): 12–17. https://doi.org/10.1111/1467-923X.12221.

Riley-Smith, Ben, and Ben Farmer. "RAF Jets Scrambled More Than 40 Times to Intercept Russian Bombers." *Daily Telegraph* (February 21, 2015). https://www.telegraph.co.uk/news/uknews/defence/11426692/RAF-jets-scrambled-more-than-40-times-to-intercept-Russian-bombers.html. Accessed March 12, 2017.

Stocker, Jeremy. *Britain's Role in U.S. Missile Defense* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2004).

Taylor, Claire. *UK Defence Procurement Policy* (London: House of Commons Library, 2003): 27. http://www.parliament.uk/briefing-papers/RP03-78/uk-defence-procurement-policy. Accessed March 16, 2017.

Taylor, Trevor. "'Que Sera, Sera': The UK and the F-35." *RUSI Newsbrief*, 33 (2) (March 2013): 1–3. https://rusi.org/publication/newsbrief/%E2%80%98que-sera-sera%E2%80%99-uk-and-f-35. Accessed March 2, 2017.

U.S. Department of State. *Defense Communications: Memorandum of Understanding Between the United States of America and the United Kingdom of Great Britain and Northern Ireland Signed at Corsham and Offutt AFB March 16 and May 9, 2007 with Annex and Agreement Amending the Memorandum Signed at Abbey Wood and Offutt AFB, December 4, 2007 and January 18, 2008* (Washington, DC: Department of State, 2013). http://permanent.access.gpo.gov/gpo36384/183520.pdf. Accessed March 6, 2017.

JSF and Denmark, Israel, Italy, and Japan

Interest in purchasing the JSF has not been confined to the United States and other Anglosphere countries. It also applies to other US allied countries who may or may not be part of the North Atlantic Treaty Organization (NATO). These countries encompass multiple global regions and have their own domestic political, economic, and strategic reasons for wanting to participate in the JSF program and purchase the JSF. This chapter examines some of the factors prompting these countries' interest in the JSF despite the problems it has experienced in previously examined countries.

Before covering these countries' involvement with the JSF, we must briefly examine the presence of other advanced jet fighters which may meet these countries airpower needs. These fighters include the Dassault Aviation Rafale, Eurofighter Typhoon, and Saab-Gripen. Dassault Aviation is a French-based aerospace company headquartered in Paris with other facilities and suppliers in France and multiple international countries including China, India, and the United States. It is a key supplier of aircraft to the French military while also selling aircraft to other countries. The Rafale is a jet fighter used by the French Air Force and Navy. It began service in the French Navy in 2004 with ten of these aircraft operating on the *Charles de Gaulle* aircraft carrier. The air force variant of this fighter began service in June 2006.[1]

France initially ordered 180 Rafales, with 132 going to the Air Force and 48 to the Navy, with 100 of these being delivered by the end of 2010. These aircraft first saw action in March 2007 when they were deployed to

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_8

Tajikistan as part of NATO's International Security Assistance Force in Afghanistan. The French Government ordered 60 additional Rafales in November 2009 and January 2010 saw Brazil's government award a $4 billion contract to Dassault for 36 of these aircraft. Negotiations to sell the Rafale to the United Arab Emirates in 2011 were unsuccessful, but in February 2012 India purchased 126 Rafales for $20 billion with the first 18 fighters to be supplied by 2015 and the remaining fighters produced in India by Hindustan Aeronautics. On February 16, 2015, French Defense Minister Jean-Yves Le Drian and Dassault Aviation Chair Éric Trappier signed an agreement to sell 24 Rafales to Egypt in Cairo.[2]

The Rafale M is the only non-US fighter capable of operating from the decks of US aircraft carriers as demonstrated by six of these aircraft successfully operating from the *USS Theodore Roosevelt* during 2008. It has also seen action in operational theaters as varied as the Central African Republic, Iraq, Libya, and Mali. Rafale technical capabilities including the dimensions, weight, performance, and weapons are shown in Table 8.1.

Table 8.1 Rafale technical capabilities[3]

Wing span	10.90 meters (35.76 ft.)
Length	15.30 meters (50.19 ft.)
Height	5.30 meters (17.38 ft.)
Overall empty weight	10 tons (22,000 lbs) class
Max. take-off weight	24.5 tons (54,000 lbs)
Fuel (internal)	4.7 tons (10,300 lbs)
Fuel (external)	Up to 6.7 tons (14,700 lbs)
External load	9.5 tons (21,000 lbs)
Maximum thrust	2 × 7.5 tons
Limit load factors	−3.2 g/+9 g
Maximum speed	M = 1.8/750 knots
Approach speed	Less than 120 knots
Landing ground run	450 meters (1500 ft.) without drag chute
Service ceiling	50,000 ft.
Weapons	MICA Beyond Visual Range interception; combat; and self-defense missiles; HAMMER rocket boosted precision-guided weapons; AM39 Exocet anti-ship missile; Laser-guided bombs 30 mm internal cannon

Eurofighter is a consortial effort involving Austria, Germany, Italy, Saudi Arabia, Spain, and the United Kingdom. Founded in 1986, and registered in Munich, it employs a workforce of over 100,000 from 400 companies.[4]

The Eurofighter Typhoon's initial prototype began in 1989 with Chiefs of Air Staff from Germany, Italy, Spain, and the United Kingdom agreeing on their advanced aircraft requirements. Workshare production was agreed on in 1996 and subsequent years saw extensive environmental, weapon-firing, in-flight fueling, and supersonic speed tests occur. Between 2003 and 2005, Typhoon was incorporated into these four countries' air forces and the aircraft received defensive aid subsystems, the multifunctional information and distribution system, initial direct voice input, and sensor fusion systems. During 2005, the United Kingdom signed an agreement with Saudi Arabia that the Eurofighter would replace Saudi Tornado fighters. Typhoons patrolled Italian skies during the 2006 Winter Olympics in Turin, Austria's Air Force received its first Typhoon in 2007, and Saudi Arabia received its first aircraft in 2008. Subsequent years have seen continual updates to Typhoon with it conducting combat missions in Libya during 2011 and Oman has commissioned 12 Typhoons to begin service in 2017.[5]

During 2016 British Typhoons used their cannons in actions against Daesh in Iraq and Syria and the British Government announced that Typhoon's life would be extended until 2040. On November 30, 2017, BAE systems and MOD announced that Qatar was slated to purchase 24 Typhoons.[6]

As of 2017, Eurofighter Typhoon's ownership and orders consist of several hundred aircraft with the following national breakdowns (Table 8.2).

Specific Typhoon technical dimension and mass attributes are shown in Table 8.3.

Design characteristics include a single-seat twin engine with a two-seat variant and additional capabilities (Table 8.4).

General performance characteristics with a full air-to-air missile fit are shown in Table 8.5.

Table 8.2 Eurofighter Typhoon national distribution[7]

Austria	16
Germany	180
Italy	121
Kuwait	28
Oman	12
Saudi Arabia	72
Spain	87
United Kingdom	232

Table 8.3 Typhoon technical capabilities

Wingspan	10.95 m (35 ft. 11 in)
Overall length	15.96 m (52 ft. 4 in)
Height	5.28 m (17 ft. 4 in)
Basic mass empty	11,000 kg (24,250 lbs)
Maximum take-off	>23,500 kg (51,809 lbs)
Maximum external load	>7500 kg (16,535 lbs)

Table 8.4 Additional Typhoon technical capabilities

Weapon carriage	13 hardpoints
G-Limits	+9/−3 "g"
Engines—two Eurojet EJ200 reheated turbofans	
Max dry thrust class	60 kN (13,500 lbs)
Max reheat thrust class	90 kN (20,000 lbs)

Table 8.5 Typhoon technical capabilities with full air-to-air missile fit[8]

Ceiling	>55,000 ft.
Brakes off to 35,000 ft./M 1.5	<2.5 minutes
Brakes off to lift-off	<8 seconds
At low level, 200 KTS to Mach 1.0 in 30 seconds	
Maximum speed	Mach 2.0
Operational runway length	<700 m (2297 ft.)

The Saab-Gripen fighter is produced by Sweden's Svenska AeroPlan Aktiebologat (Saab, Swedish Aeroplane Corporation) industries headquartered in Stockholm, with additional locations in Sweden and multiple other countries globally, and Volvo Aero Corporation. The Gripen's design was influenced by the unforgiving Nordic climate and the need for Sweden to make optimal use of limited budget resources to develop a fighter capable of performing air-to-air, air-to-surface, and reconnaissance missions in a single sortie without having to return to base. Gripen was also designed to use roads as temporary runways, give the Swedish Air Force logistical flexibility and speed to deter invading forces, and be easily maintained and reconfigured.[9]

The Gripen was first flown in 1988 and began Swedish Air Force operational service in September 1997 when Sweden's decided it needed to upgrade Cold War-era jet fighter aircraft. It comes in the following variants:

- JAS 39A Single-seat
- JAS 39B Operational trainer with same avionics and weapons as 39A except for the gun.

- JAS39C Single-seat delivered to the Swedish Air Force in September 2002. Features color cockpit displays, an onboard oxygen generation system, and in-flight refueling capacity. Serves as the standard export version.
- JAS39D Two-seat variant with similar capabilities to the JAS39A.[10]

In October 2007, the Swedish Government contracted with Saab for a new Gripen version featuring full interoperability with NATO aircraft, high operational tempo, a fully digitized cockpit, network connectivity with multi-frequency datalink, and a modern avionic system. The government also approved upgrading 31 JAS39A's to JAS39C/D and the first successful flight by this upgrade was completed in February 2009. The Gripen made its international debut in July 2010 at the United Kingdom's Farnborough International Air Show.[11]

Saab has sought to market the Gripen by emphasizing what it says are its cheaper per hour flight operational costs than competing jet fighters as Table 8.6 from company promotional literature demonstrates:

Countries purchasing the Gripen include Brazil, which will receive 28 single-seat and 8 double-seat Gripens between 2019 and 2024; the Czech Republic which has received 14 fighters; Hungary has purchased 14 fighters; South Africa has purchased 26 fighters; Sweden has purchased 204 fighters, and Thailand has purchased 12 fighters.[13]

On October 29, 2014, the Swedish Government announced it would be increasing its Gripen purchases by 2.9 billion Swedish krona ($3.351 billion) over the next two years in response to increasing Russian aggressiveness in the Baltic Sea and Ukraine. On May 18, 2016, Defense Minister Peter Hultqvist announced the first Gripen-E test aircraft which he said would become operational in 2020. Hultqvist also visited Hungary on September 26–27, 2017, to see the Gripen at Kecskemét Air Base.[14]

Gripen technical specifications in areas such as dimensions, power, and armament are shown in Table 8.7.

Table 8.6 Hourly fighter operational costs[12]

Gripen $4700
F-17 $7700
F-18/E/F $11,000
Rafale $16,500
Rafale $18,000
JSF $31,000

Table 8.7 Gripen technical capabilities[15]

Length	15.2 meters (49.869 ft.)
Width	8.6 meters (28.215 ft.)
Mass when empty	8000 kg (17,636 lbs)
Internal fuel capacity	3400 kg (7495 lbs)
Maximum take-off weight	16,500 kg (36,376 lbs)
Maximum thrust	98 kN
Minimum take-off distance	500 meters (546.80 yards)
Landing distance	600 meters (656.16 yards)
Maximum sea-level speed	>1400 km/h (869 miles)
Maximum high-altitude speed	Mach 2
Supercruise capability	Yes
Maximum service altitude	>16,000 meters (9 miles)
Ferry range	4000 km (2485 miles)
G-Limits	+9G/−3G
Air-to-air infrared missiles	
Air-to-air radar missiles	
Anti-ship missiles	
Smart bombs	
Smart diameter bombs	

Denmark

Denmark's primary fighter has been the F-16 since the 1970s, but Copenhagen has been interested in updating its fighter capacity to maintain its interoperability with the United States. It has experienced economic and political headwinds which have also made its purchase of the JSF a protracted process. In September 1997, Denmark became a partner country in JSF's initial requirements validation phase. This occurred from the leadership of then Defense Minister Hans Hækkerup, in convincing Denmark's Parliament (Folketing) to appropriate $10 million to cover Danish participation in what was seen as a primarily industrial project. During May 1999, the Folketing decided to sign up for JSF's System Development and Demonstration (SDD) phase between 2000 and 2004. In 2002, Denmark decided to contribute an additional $125 million to JSF becoming a Level 3 partner county. Danish policymakers at this time planned acquiring 48 JSFs for their military.[16]

Between 2005 and 2008, the Danish Defense Department sent out Requests for Information (RFI) to Dassault Aviation, Eurofighter, Lockheed Martin, and Saab Air. Dassault decided not to provide information convinced that Lockheed Martin would win because they felt the RFI favored the JSF. These concerns were rejected by a Danish defense policymaker in October 2012. Eurofighter announced it would not participate in the competition in December 2007 citing the same concerns as Dassault. In February 2008, the Folketing appropriated $330 million to take part in the JSF's third and final phase covering Production, Sustainment, and Follow-on Development.[17]

This general time period also saw Denmark's Defense Department, the Government's audit office (Rigsrevisionen), and other entities examine the competing fighter companies including Boeing's F-18 Super Hornet which entered the competition in 2008. The Rigsrevisionen report in March 2009 operated on the assumption that Denmark would purchase 48 JSFs while acknowledging that fewer aircraft than the current fleet of 48 F-16s would be needed to perform the same security tasks and that the number of competing aircraft needed varied depending on the candidates' different capabilities. This assessment also examined the costs of 24, 36, 48, and 60 JSF aircraft. Additionally, it stressed that the aircraft selected must meet the following standards:

- Broadly deployable—Serve as a multirole combat aircraft capable of multiple tasks in national and international contexts.
- Compatible—Deployable in a NATO context and able to operate in other NATO capabilities.
- Survivable—Possess sufficient self-defense capability.
- Network-Based—Capable of operating in a network with other platforms and capabilities.
- Penetrative—Capable of participating in the first wave of offensive air operations and getting past enemy air defenses relatively unobserved to deliver precision weapons early in a conflict.
- Enduring—Capable of providing long-term support to complex ground operations including stabilization operations.
- Available—Capable of taking over tasks carried out by F-16s before these aircraft are phased out.
- Prevalent—Produced and deployed in large numbers.
- Economical—Operable within the scope of current combat air capability.[18]

In June 2009 all major Folketing parties voted for a five-year defense spending agreement which included reducing the number of proposed new fighters to purchase from 48 to 30 without committing to a specific plane.

Repeated purchasing postponement decisions have occurred since then. In October 2009 Defense Minister Søren Gade deferred the decision to spring 2010. During March 2010 Defense Minister Gitte Lillelund Bech said the process would be delayed for another two to four years. A 2010 Danish Air Force report maintained that phasing out the F-16s could be delayed until 2018–2020. These delays have resulted from domestic financial problems and concerns over continually rising JSF program costs.[19]

Denmark currently has 30 F-16 fighters making up the mainstay of its fighter force. A January 2015 *Aviation Week and Space Technology* analysis predicted Denmark will make a decision on whether to purchase the JSF or some other new generation fighter that year though whether that purchase actually occurs remains unknown. This deadline of a summer 2015 combat aircraft purchase decision was also specified in the 2013–2017 *Danish Defence Agreement* involving parties participating in Denmark's coalition government within a price framework of 50 million Danish kroners (DKK) ($7.182 million) covering 2013–2016.[20]

On June 9, 2016, Denmark's coalition government consisting of the Social Democrats, Social Liberals, Liberal Alliance, and Danish People's Party decided for 27 JSFs to replace the F-16s between 2020 and 2024. In its recommendation document, the Danish Government stressed the JSF "will entail the greatest potential for promoting Danish interests, in terms of both security policy and military strategy … and provide the highest degree of flexibility at the political level with regards to future tasks." It went on to emphasize the JSF will foster transatlantic ties with the US and European partners and that it ranked higher than the Eurofighter and F-18 Super Hornet in terms of survivability, mission effectiveness, future development, and candidate risk. The Danish krone 26.5 billion ($3.763 billion) industrial cooperation benefit was also higher than those for the Eurofighter and F-18.[21]

Danish JSF Industrial Participation

Danish companies are contributing to the JSF in areas such as advanced composites, aeronautical structures, machine parts, and wiring harnesses. Danish involvement in JSF production is shown in Table 8.8.

Danish companies, however, have been concerned by what they see as a lack of effort by the Danish Government to win more JSF systems and components. Danish Aerotech CEO Jan Jørgensen complained that Danish companies had only received $138 million in JSF contracts

Table 8.8 Danish JSF contractors[22]

Danish Aerotech Karup	Mechanical parts
Systematic Aarhus	Software and electronic warfare assets
Terma Aarhus	Large composite skins for horizontal and vertical tail, 25 MM gun pod

since 1997. During 2009, Denmark's government had contended that Danish firms could potentially receive JSF contracts worth up to $4.9 billion. Jørgensen, the leader of the Danish Defense and Aerospace Federation, in 2012, complained, "Danish governments have probably been a little too unassertive and reluctant, compared to Norway." Terma has accounted for nearly two-third of JSF orders and then Defense Minister Nick Hækkerup urged his country's defense industry to be patient and continue bidding for JSF contracts. In 2017, Danish JSF contracts were $356 million.[23]

Competition for lucrative national defense contracts can be very fierce and this was proven when Super Hornet producer Boeing publicly protested Denmark's awarding the JSF to Lockheed Martin in September 2016. Boeing complained the evaluation process was flawed and unfair and submitted an RFI to Denmark's Defense Ministry at that time in an effort to gain access to internal Danish government documents and also expressed its concerns to the Folketing's Defence Committee. Boeing's Defense Europe representative Marcia Costley complained that Danish defense officials "shared only a small portion of the documents Boeing is entitled to review." In March 2017, Boeing filed suit against the Defense Ministry in Copenhagen District Court for refusing to show documents on the contract evaluation process. Danish Defense Minister Peter Christensen responded by asserting that losing bidders for government contracts are never happy with the outcome.[24]

Israel

Israeli interest in the JSF has been prompted by the need to replace its aging fleet of F-16 fighters. During 2001, Israel Aircraft Industries (IAI) (later Israel Aerospace Industries), which has frequently cooperated with Lockheed Martin, expressed interest in joining the JSF project.[25] During

2002, IAI and other Israeli defense industry companies lobbied Israel's government to get involved in the JSF citing their desire to gain JSF contracts as soon as possible and to give Israel stealth aircraft in light of what they then saw as emerging threats from Iran and Iraq. The Israeli government, however, expressed concerns about the costs involved in participating in JSF even at Level 2 and 3 partnership participation and Israel's military favored two-seat aircraft to accommodate its belief that two pilots are better than one when dealing with sophisticated air defenses.[26]

In late 2007, Israeli Air Force (IAF) officials expressed hope they could purchase 100 JSFs from the United States by 2012 and that they could resolve disagreements with the United States on incorporating indigenous weaponry such as avionics into the JSF, and to what extent Jerusalem can independently develop JSF industrial capabilities. These hopes were increased by the Bush Administration's August 2007 decision to increase US military assistance to Israel $6 billion over the next decade.[27]

In September 2008, Israel requested 75 JSFs from the United States at an estimated $15 billion price. However, increasing plane costs were also becoming a concern to Israeli military planners. One Israel Defense Force (IDF) General Staff member was quoted as saying: "It's unbelievable, first it was $40 million [per plane] to $50 million, and then they [the IAF] told use $70 million to $80 million. Now we're looking at nearly three times that amount, and who's to say it won't continue to climb?"[28]

On September 19, 2010, Israel's cabinet approved acquisition of the JSF with Prime Minister Benjamin Netanyahu saying:

> This is a significant step in strengthening the State of Israel's military capabilities. I would like to commend the staff work that was done by the security establishment and the IDF and which led to the integration of [Israeli] systems into the plane. The plane is currently being developed and will be equipped in the coming years. This is one of our answers to the changing threats around us, to maintain our attack capabilities, along with other actions to improve both our defensive and offensive abilities in the decades to come. We will hold separate discussions on these, but I think that this step, acquiring the most advanced plane in the world, more advanced than any plane in the area, is an important and significant step for the security of Israel.[29]

The following day, the Israeli Knesset's Finance Committee approved purchasing 20 JSFs for $2.75 billion ($96 million per aircraft). This agreement also included purchasing spare parts, maintenance costs, and simulators, with delivery expected in 2015. Defense Minister Udi Shani said that Israel could purchase up to 75 JSFs in subsequent years. Israeli purchase of these planes was also facilitated by the United States paying for it through Foreign Military Financing Funds administered by the Defense Security Cooperation Agency (DSCA).[30]

During 2011, the US-Israel reached an agreement allowing the Israelis to adapt the JSF to use indigenously developed electronic warfare equipment and countermeasures once it receives its first aircraft. Lockheed Martin JSF Program Manager Tom Burbage said he thought the first JSFs would arrive in Israel in late 2016. He also said that he hoped Israelis could begin training on the JSF in the United States in 2016, but that this matter still needed to be resolved.[31] On April 22, 2013, Israeli Defense Minister Moshe Ya'alon and US Secretary of Defense Chuck Hagel agreed to extend US security funding for Israel through 2017, with this funding reaching an all-time high of $3.1 billion in 2013 and including Israeli participation in the JSF.[32]

In November 2014, the cornerstone for the IAF's JSF squadron and simulator infrastructure was laid at Nevatim Airbase southeast of Beersheba and on the edge of the Negev Desert.[33] Though Israel appears to be going ahead with incorporating the JSF into the IDF's striking power, this has not occurred without opposition in Israeli political and military debate. A November 5, 2014, meeting of high-level Israeli policymakers including Strategic Affairs Minister Yuval Steinitz, Finance Minister Yair Lapid, former Defense Minister Moshe Arens, and others expressed concerns with JSF program costs exceeding $3 billion. Additional concerns they expressed included recent fighting in Gaza, along with developments in Lebanon and Syria, which they contend make it necessary for Israel to invest in precision munitions, UAVs, and ground forces equipment instead of the JSF. This opposition did not stop Israel's cabinet from approving the purchase of 14 additional JSFs on November 30, 2014, but these cost concerns expressed by Steinitz and others have slowed down purchases of this plane. Additional potential Israeli purchases of the JSF are also uncertain due to the concerns of some IDF security officials that hostile missile capabilities increase the vulnerability of Israeli airfields and that planned JSF purchases are not enough to maintain regional Israeli air superiority against threats such as Iran.[34]

In November 2016, Israel agreed to purchase an additional 17 JSFs, bringing its cumulative on order total to 51, and Jerusalem has received US approval to purchase up to 75 aircraft with potential revenue purchases reaching $15.2 billion. Terms of this agreement see the United States agree to make reciprocal purchase of equipment from Israeli defense companies which could reach $4 billion. Israeli companies had received $993 million for building JSF components in business from Lockheed Martin as of 2016. Israel became the first country to receive the JSF outside of the United States when two fighters arrived at Nevatim Air Base on December 12, 2016, at a ceremony attended by Netanyahu and US Secretary of Defense Ashton Carter. Israel expects to receive an additional seven or eight JSFs a year until 2021. These JSFs will receive Israeli-made command, control, computers, and communications systems and the aircraft will be called *Adirs*.[35]

Israeli Industry JSF Participation

Israeli firms have currently signed contracts worth $688 million with Lockheed Martin and Pratt & Whitney to produce software and other JSF components. The first two JSFs were expected to arrive in Israel in late 2016, with more planes being delivered annually until 2021. Examples of Israeli companies involved in JSF production are shown in Table 8.9.

An October 2017 analysis from Israel's Begin-Sadat Center for Strategic Studies Israel's Joint Strike Fighter stressed that the JSF could evade various hostile radar systems in Israel's Northern arena, play a key role in Jerusalem's efforts to stop Iran and its proxies from creating a threatening Syrian military outpost, guard against Hezbollah's heavily armed artillery assets in Lebanon, and boost Israeli long-range capabilities. On December 6, 2017, Israeli Air Force leader Major General Amikam Norkin announced that the JSF had joined Israel's Air Force (Fig. 8.1).[37]

In May 2018, Israel engaged in the first known combat use of the JSF when it attacked Iranian and Hezbollah military targets near Beirut. Norkin stressed, "We are flying the F-35 all over the Middle East. It has

Table 8.9 Israeli JSF contractors[36]

Elbit Systems Haifa	Avionics, video imagery
Israeli Aerospace Industries Ashdod, Lahav	Wings, electronic warfare equipment
Rafale Advanced Defense Systems Haifa	Missiles

Fig. 8.1 Israel's Minister of Defense Avigdor Liberman in the cockpit of the F-35A Lighting II, June 22, 2016. Source: Lockheed Martin 2016

become part of our operational capabilities. We are the first to attack using the F-35 in the Middle East and have already attacked twice on different fronts." Lockheed Martin President and CEO Marillyn Hewson said the JSF, working in concert with IDF ground forces and Navy, had been "critical" in counteracting Hezbollah missiles due to the JSF's C4I technology facilitating target rapid identification and prioritization for the IAF with the *Adir* capable of carrying up to 18,000 pounds of external and internal ordnance. Lockheed Martin International Executive Vice-President Rick Edwards emphasized, "We aren't building this aircraft for a fair fight, but to give our customer a decisive advantage."[38]

Italy

Italian participation in the JSF began in 1998 when the leftist government of Massimo D'Alema invested $10 million in JSF's Concept Demonstration Phase. In 2002, Silvio Berlusconi's conservative government committed

$1.028 billion to JSF's System Design and Development phase and signed a MOU with the United States on June 22, 2002. In 2007, Romano Prodi's leftist government sighted a bilateral MOU worth $904 million for a Production, Sustainment, and Follow-On Development Phase. Berlusconi was back in power in 2009 when the Italian Parliament approved acquiring 131 F-35 including 69 CTOL variants and 62 STOVL variants and the Italian government also agreed to construct a Final Assembly and Checkout Facility (FACO) and Maintenance, Repair, Overhaul, and Upgrade (MRO&U) facility at Cameri committing an additional $796 million in infrastructure. These FACO and MRO&U agreements also involved a 2006 agreement with the Netherlands to share these operational capabilities.[39]

Debate over the JSF's increasing cost has characterized Italian political debate. Rome was forced to adopt austerity measures due to the 2011 Eurozone crisis which affected the February 2013 election. On February 15, 2012, Italian Defense Minister Admiral Giampaolo Di Paola announced defense spending reductions of 5.5% and this resulted in reducing the number of JSF planes to be acquired from 131 to 90 split roughly equally between CTOL and STOVL variants. This year also revealed that cumulative Italian spending on JSF had reached €2.5 billion ($2.684 billion). Opponents of the JSF have included a wide spectrum of groups including the radical left, pacifist Catholics, and right-wing populist movements who favor devoting more resources to social programs. JSF supporters have included mainstream parties from the center-left to center-right, the military establishment, defense experts, and the moderate mass media who assert Italy should maintain its close security ties and military interoperability with the United States.[40]

JSF's future prospects were placed in further doubt by a March 19, 2014, Italian Parliamentary Committee report calling for significant cuts to the program and for creation of a new defense white paper to reassess military strategy. The report was prepared by allies of center-left Prime Minister Matteo Renzi and it criticized the allegedly poor Italian JSF workshare, insufficient job generation, and Italy's lack of access to sensitive program data enhancing its dependence on the United States. The report also contended that Italy's planned €12 billion ($12.887 billion) purchase of 90 aircraft should be significantly reduced and that ongoing orders should be halted until technical problems are resolved.[41]

On March 8, 2015, the first Italian-produced JSF rolled off the FACO facility at Cameri with an anticipated to make its first flight later that year which occurred on September 7, 2015. Seven additional aircraft are being assembled at this facility, although the future of Italy's JSF program remains uncertain due to budgetary and political challenges. The need to maintain interoperability and close cooperation with the United States and its NATO allies makes it likely Italy will purchase some JSFs though the exact amount and financial value of these purchases is uncertain.[42]

During 2016, Italian pilots began JSF training at Luke Air Force Base in Arizona. Italy received its first JSFs on December 12, 2016, when the Italian Air Force received two aircraft at Amendola Air Base on the Adriatic Coast. A 2016 Italian Defense Ministry document submitted to the Italian Parliament by Defense Minister Roberta Pinotti maintained the JSF would be deployed between 2018 and 2025 and replace many existing Italian Air Force weapons platforms.[43]

In May 2017, Italy unveiled the first JSF assembled outside the United States when an F-35B STOVL was produced at the Cameri FACO facility. However, criticism of Italian production capacity occurred with the Italians criticizing Lockheed Martin and the US JSF Joint Program Office for not providing sufficient materials for JSF-related work, that this facility had only assembled 119 of 214 promised aircraft, that only 31% of promised wing sets had been produced, that the workforce size was far less than projected, and that British and Dutch firms had won work originally promised to Italy.[44]

Italian JSF Industrial Participation

Italian industry has received $1.35 billion in JSF contracts as of December 2016. A 2014 study by the Italian branch of PricewaterhouseCoopers maintained that Italian JSF peak production would generate over 6300 jobs, that peak JSF project labor demand would occur between 2017 and 2026, that this program would bring $15.8 billion in economic benefits, and that each JSF production job would generate 1.2 Italian jobs.[45] Italian JSF industrial participation spans much of this peninsular country with contributors coming from locales as varied as Campania, Lazio, Liguria, Lombardy, Piedmont, Puglia, and Tuscany. Selected examples of Italian JSF contractors and their contributions are shown in Table 8.10.

Table 8.10 Italian JSF contractors[46]

Aerea Milan	Advanced rail launcher, fuselage remote interface unit components; and electro-hydraulic actuation system components
Alenia Aeronautica Campania and Turin	Wing box and wing production
Elettronica Rome	Electronic warfare components and logistical support
Finmeccanica Turin and Novaro	Wingbox; final assembly; and checkout facility
Forgital Venice	Forging; hot rolling; and mechanical processing of circular section rings
Genelli Rome and Canegrate	Protective headsets
Logic Rome	Avionics
Moog Casella Genoa	Electro-hydraulic actuation system components
Oto Melara Spezia	Gun for conventional take-off and landing variant
Rotodyne Saronno	Hydraulic test stands; hydraulic and mechanical lifting devices; ground power units; frequency converters.
Selex Communication (Marconi) Montevarchi, Pomezia, and Rome	Landing aids down converter and back-up radio
Sirio Panel Montevarchi	Cockpit lighting and panels

Japan

Japan is the largest US ally in East Asia. Its fighter arsenal has consisted of the aging F-4 and emerging security challenges from China are forcing it to look at upgrading its fighter aircraft capability. An example of this is the increasing incursions of Chinese aircraft into Japanese airspace. This has resulted in a significant increase in Japanese Air Self-Defense Force (JASDF) planes having to scramble to intercept Chinese jet fighters from just under 100 times in Fiscal Year (FY) 2010 (April 1–March 30) to over 400 times in FY 2013 and a combination of Chinese and Russian jet fighters 943 times in 2014, just below the 1984 record of 944 scrambles to Soviet aircraft. This increasing need for Japan to scramble its military aircraft against Chinese and Russian incursions continued in the first quarter of Japanese FY 2016 (April–June 2016) when Tokyo's aircraft scrambled 281 times against these Beijing and Moscow's aircraft incursions into Japanese airspace, with 71% of these incursions being Chinese and 28% being Russian.[47] The final total of Japanese aircraft scrambles for FY 2016 released on April 13, 2017, was 1168, totaling 295 above the previous fiscal year and representing the highest number since 1958 with 73% of these intercepts being against Chinese aircraft and 26% against Russian aircraft.[48]

During the 2000s, Japan considered six aircraft as possible candidates to replace the F-4 including the Rafale, Eurofighter Typhoon, updated versions of the F-18 and F-15, the F-22, and JSF. The selection process was reduced to the Eurofighter Typhoon, and the JSF's conventional version. An open and transparent procurement process occurred in which the JASDF requested bids, collected them, and studied them. This resulted in a recommendation that the JSF be selected by Japan's Security Council which agreed to purchase 42 JSFs on December 19, 2011, without providing pricing information. Reasons given for selecting the JSF spelled out in Japan's 2012 *Defence White Paper* included its advanced stealth performance which this document concluded gave it a combat advantage, its diverse sensor assets giving it the ability to acquire essential intelligence, a networking capacity facilitating information sharing with allies, and pilot ability to access sensor information in a single display.[49]

The open procurement process, Japan's desire to remain part of the US military alliance, and public and governmental focus on trying to recover from the 2011 Fukushima nuclear plant disaster combined to keep the JSF from becoming a tumultuous political controversy in Japan.[50]

Tokyo desired to begin receiving the JSF in 2016 and is particularly attracted to stealth features such as internal weapons storage for air-to-air missions and improved ability to penetrate North Korean defenses.[51] Japanese purchase of the JSF also compelled Tokyo in late December 2011 to loosen its 35-year-old ban on arms export sales facilitating cooperative development and production with Democratic allies from Europe and Australia. This decision also represents a reversal of Japanese policy of restricting its defense production to only Japanese companies.[52]

The yen's depreciating value in early 2014 prompted speculation that Japan would have to chronologically draw out its planned acquisition of 42 JSFs from 2021 to 2023. This time period also produced media speculation that Japan would purchase the JSF's naval variant to establish a naval aviation capacity on its new 27,000-ton Izumo class helicopter carriers.

However, former Japanese Maritime Self Defense Forces Commander Yoji Koda rejected this in January 2014, saying funding for this would have to come from other programs which he contended was unlikely in the short or medium term.[53]

Visiting the JSF production facility in Fort Worth on July 8, 2014, Defense Minister Itsunori Onodera said Japan should consider buying more F-35s if the price falls. Japan is currently purchasing the JSF as part of the US Foreign Military Sales Program.[54]

In its FY 2015 defense budget document, Japan reported its intention to acquire six JSF for ¥103.2 billion ($857.527 million) with ¥17.7 billion ($1.470.760 billion) allotted for promoting Japanese domestic industrial participation and ¥18.1 billion ($1.504 billion) allotted for training and machinery.[55] Misawa Air Force Base, a combined US Air Force and Japanese Air Self-Defense (JASDF) facility in Northern Japan, is slated to become the home for JSFs once they arrive in Japan in 2017.[56]

On September 23, 2016, State Minister for Defense Kenji Wakamiya attended the rollout ceremony for Japan's first JSF at Lockheed Martin's Fort Worth production facility. Wakamiya noted that a deteriorating security environment in Japan's surrounding airspace makes JSF acquisition particularly significant to Japan; that it enhances the Japanese-US alliance; that a facility for establishing, maintaining, repairing, and upgrading the JSF will be established in Japan; and that this ceremony deepens defense cooperation between these two countries. The 2016 *Defence of Japan* White Paper noted Japan needed the JSF to deal with potential Chinese attacks on remote islands, Beijing's increasing defense spending, anti-access aerial denial activities, airpower and UAV capabilities, and naval activities in seas adjoining Japan, increasing Russian defense spending, and Asia-Pacific region military activities. These developments have also caused Japanese defense spending to increase from $46.107 billion in 2014 to $47.342 billion in 2016 and the size of its active duty military forces to increase to 247,000 in 2017. The increasing threat from North Korean ballistic missiles is also accelerating Japanese interest in the JSF and enhancing its missile defense capability.[57]

On June 5, 2017, Mitsubishi Heavy Industries Komaki South FACO facility rolled out the first Japanese-assembled JSF. Japan has purchased 42 JSFs, with 4 assembled in Fort Worth and the remaining 38 to be assembled in Japan and the United States will use the Nagoya FACO for JSF maintenance repair and upgrade. On October 30, 2017, two JSFs arrived at Japan's Kadena Air Base with an additional ten JSF expected to arrive at Okinawa in the soon after.[58]

Table 8.11 Japanese JSF contractors[59]

IHI Corporation Tokyo	Engines
Mitsubishi Electric Corporation Tokyo	Mission-related avionics
Mitsubishi Heavy Industries Hokkaido; Nagoya; Tokyo; Yokohama	Aircraft assembly and checkout

Japanese Industry JSF Participation

Deployment of the JSF in Japan is expected to occur in 2017 with a total of 42 aircraft expected to be purchased though it is possible this could increase. Examples of Japanese firms involved in various aspects of JSF production and maintenance are shown in Table 8.11.

Notes

1. "Rafale Multirole Combat Fighter, France," *Air Force Technology* (2015): 1–2; http://www.airforce-technology.com/projects/rafale/; accessed April 10, 2017.
2. See Ibid., 3; Dassault Aviation, "Signing Ceremony of the Sales Contract for Rafale to Egypt, 2015/02/16 (Paris: Dassault Aviation, 2015): 1; http://www.dassault-aviation.tv/signing-ceremony-of-the-sales-contract-for-rafale-to-egypt-1150-en.html; accessed April 10, 2017; Patrick Keller, *Challenges for European Defense Budgets after the Economic Crisis* (Washington, DC: American Enterprise Institute, 2011); https://www.defencetalk.com/challenges-for-european-defense-budgets-after-the-economic-crisis-35589/; accessed June 8, 2018; and Dorothée Foucheaux, *French Hard Power: Living on the Strategic Edge* (Washington, DC: American Enterprise Institute, 2014); http://www.aei.org/wp-content/uploads/2014/02/-french-hard-power-living-on-the-strategic-edge_162239575985.pdf; accessed April 10, 2017.
3. Dassault Aviation, *Rafale: The Omnirole Fighter* (Paris: Dassault Aviation, 2015): 9, 12, 16, 18–19; http://www.dassault-aviation.com/wp-content/blogs.dir/2/files/2015/02/4-Defense-2015.zip; accessed April 11, 2017.
4. See Eurofighter Typhoon, *About Us* (Munich: Eurofighter, 2015): 1; http://www.eurofighter.com/about-us; accessed April 11, 2017; "Transforming Typhoon," *Aerospace America*, 52 (1) (January 2014): 4–5.
5. See *About Us*, 4–5; and Ian Davis and Emma Mayhew, *What Happens When a White Elephant Meets a Paper Tiger?: The Prospective Sale of Eurofighter*

Typhoon Aircraft to Saudi Arabia and the EU Code of Conduct on Arms Exports (London: British American Security Information Council, 2005); https://www.files.ethz.ch/isn/17188/BASIC%20PAPERS.pdf; accessed June 11, 2018; provides stringent criticism of this British decision.
6. See George Allison, "Typhoon Uses Cannon in Combat," *UK Defence Journal* (June 6, 2016): 1–2; https://ukdefencejournal.org.uk/typhoon-uses-cannon-combat/; accessed January 4, 2018; and "What Next for Typhoon," *Combat Aircraft* (November 30, 2017): 1; http://www.combataircraft.net/2017/11/30/what-next-for-typhoon/; accessed January 4, 2018.
7. See Eurofighter Typhoon, *Technical Guide* (Munich, Eurofighter, 2013): 50; www.eurofighter.com/downloads/TecGuide.pdf; accessed April 11, 2017; and Ibid., *Customers*, 2017; 1; https://www.eurofighter.com/customers; accessed April 11, 2017.
8. *Technical Guide*, 10.
9. See Saab Group, *Gripen NG: Performance, Facts, and Figures* (Stockholm: Saab Group, 2015): 3; http://saab.com/globalassets/commercial/air/gripen-fighter-system/gripen-ng/technical-brochure-gripen-ng-english-ver.2-jan-2015_low.pdf; accessed April 11, 2017; and Jens Ringsmose, "Investing in Fighters and Alliances: Norway, Denmark, and the Bumpy Road to the Joint Strike Fighter," *International Journal*, 68 (1) (Winter 2012–2013): 93–110, https://doi.org/10.1177/002070201306800107.
10. "Gripen Multirole Fighter Aircraft, Sweden," *Air Force Technology* (2015): 1; http://www.airforce-technology.com/projects/gripen/; accessed April 11, 2017.
11. Ibid., 2.
12. Saab Group, 14.
13. Ibid., "Gripen Users" (Stockholm: Saab Group, 2014): 2; http://saab.com/air/gripen-fighter-system/gripen/gripen/users-gripen/; accessed April 11, 2017.
14. See Sweden, Ministry of Defence., "Budget Reinforcement to the Swedish Armed Forces' Regimental- and Air Surveillance Capabilities" (Stockholm: Ministry of Defence, 2014): 1–2; http://www.government.se/articles/2014/10/budget-reinforcement-to-the-swedish-armed-forces-regimental%2D%2Dand-air-surveillance-capabilities/; accessed March 11, 2017; Ibid., "Speech by Defence Minister Peter Hultqvist at the Unveiling of the First Gripen E Test Aircraft" (Stockholm: Ministry of Defence, 2016): 1–3; http://www.government.se/speeches/2016/05/speech-by-defence-minister-peter-hultqvist-at-the-unveiling-of-the-first-gripen-e-test-aircraft/; accessed April 11, 2017; and Ibid., "Peter Hultqvist Visits the Hungarian Defence Minister" (Stockholm: Ministry of Defence, 2017): 1; http://www.government.se/articles/2017/09/peter-hultqvist-visits-the-hungarian-defence-minister/; accessed January 4, 2018.

15. *Gripen NG: Performance, Facts, and Figures*, 4, 8. See http://www.metric-conversions.org/; accessed March 12, 2017 for metric conversions.
16. Ringsmose, 96.
17. Ibid., 96–97.
18. See Mikkel Vedby Rasmussen & Hendrik Ø Breitenbauch, *Denmark's Need for Fighter Aircraft: A Strategic Analysis of the Future Need for Danish Fighter Aircraft* (Copenhagen: University of Copenhagen Centre for Military Studies, 2007); http://cms.polsci.ku.dk/english/pdf/need_for_fighter_aircraft.pdf; accessed April 12, 2017; and Denmark, Rigsrevisionen, *Report to the Public Accounts Committee on the Basis for Possible Acquisition of Combat Aircraft* (Copenhagen: Rigsrevisionen, 2009): 24, 28, 38; http://uk.rigsrevisionen.dk/media/1887782/9-2008.pdf; accessed April 12, 2017.
19. Ringsmose, 97–98.
20. See Danish Defence, *Facts and Figures: The Danish Armed Forces* (Copenhagen: Danish Defence, 2011): 36; http://www2.forsvaret.dk/eng/About/Facts/Documents/Facts_And_Figures_UK.pdf; accessed April 12 2017; Bill Sweetman, "JSF's Year Ahead," *Aviation Week and Space Technology*, 177 (1) (January 15, 2015): 20; and Denmark, Ministry of Defence, *Danish Defence Agreement 2013–2017* (Copenhagen: Ministry of Defence, 2012): 11; http://www.fmn.dk/eng/allabout/Documents/TheDanishDefenceAgrement2013-2017english-version.pdf; accessed April 12, 2017.
21. Denmark, Ministry of Defence, *Executive Summary: Type Selection of Denmark's New Fighter Aircraft: Evaluations of Eurofighter, Joint Strike Fighter and Super Hornet* (Copenhagen: Ministry of Defence, 2016): 4–9; http://www.fmn.dk/temaer/kampfly/Documents/type-selection-denmarks-new-fighter-aircrafts-english-summary5.pdf; accessed April 12, 2017.
22. See Lockheed Martin, "Denmark: Future Air Power" (Fort Worth: Lockheed Martin, 2015): 3–4; https://www.f35.com/global/participation/denmark; April 12, 2017; and William D. Hartung, *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft* (Washington, DC: Center for International Policy, 2014): 17; http://www.ciponline.org/images/uploads/publications/Hartung_IPR_0114_F-35_Promising_the_Sky_Updated.pdf; accessed April 12, 2017.
23. See Gerard O'Dwyer and Aaron Mehta, "Danish Firms Want Bigger Slice of JSF Pie," *Defense News* (October 6, 2012): 1–4; http://www.combataircraft.com/en/News/2012/10/07/Danish-Firms-Want-Bigger-Slice-of-JSF-Pie/; accessed April 12, 2017; and "Denmark: Future Air Power."
24. Andrew McIntosh, "Boeing's Dogfight with Denmark over $3 Billion Fighter Jet Contract Lands in Court," *Puget Sound Business Journal* (March 2, 2017): 1–3; http://www.bizjournals.com/seattle/news/2017/03/02/boeings-denmark-lockheed-martin-fighter-jet.html; accessed April 12, 2017.

25. "IAI Seeks Role on JSF," *Aviation Week and Space Technology*, 155 (25) (December 17, 2001): S12.
26. David A. Fulghum and Robert Wall, "Israel Nears Decision on F-35 Participation," *Aviation Week and Space Technology*, 156 (21) (May 27, 2002): 48–49.
27. See David A. Fulghum, Robert Wall, and Barry Douglas, "Never Ending War," *Aviation Week and Space Technology*, 167 (24) (December 17, 2007): 48–50; and Jeremy M. Sharp, *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2008): 2; http://emetnews.org/documents/us-foreign-aid-to-israel-2008.pdf; accessed April 15, 2017.
28. "Adir Who?: Israel's F-35i Stealth Fighters," *Defense Industry Daily* (November 18, 2014): 2.
29. Israel, Ministry of Foreign Affairs, "Cabinet Communique" (Jerusalem: Ministry of Foreign Affairs, September 19, 2010): 1; http://mfa.gov.il/MFA/PressRoom/2010/Pages/Cabinet-communique-19-Sep-2010.aspx; accessed April 15, 2017.
30. See Yuval Azulai, "Knesset Finance C'ttee Approves F-35 Deal," *Globes: Israel's Business Arena* (September 20, 2010): 1; http://web.archive.org/web/20141031070436/http://www.globes.co.il/en/article-1000589810; accessed April 15, 2017; and Jeremy M. Sharp, *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2010): 7; http://emetnews.org/documents/US-Foreign-Aid-to-Israel.pdf; accessed April 15, 2017.
31. Alon Ben-David, Amy Butler, and Robert Wall, "Wire Transfer: U.S., Israel Strike F-35 Technology Deal," *Aviation Week and Space Technology*, 173 (24) (July 4, 2011): 22.
32. U.S. Department of Defense, "Hagel, Yaalon Finalize New Israeli Military Capabilities" (Washington, DC: U.S. Department of Defense, April 22, 2013): 1; http://archive.defense.gov/news/newsarticle.aspx?id=119838; accessed April 15, 2017.
33. Shani Poms, "Cornerstone Laying for F-35 Squadron Release Date" (Jerusalem: Israel Air Force, November 11, 2014): 1–2; http://www.iaf.org.il/4415-43545-en/IAF.aspx; accessed April 15, 2017.
34. See "Contracts and Key Events 2011–2014," *Defense Industry Daily* (November 18, 2014): 4; and Avi Lewis, "Cabinet Authorizes Purchase of 14 F-35 Fighter Jets," *Times of Israel* (December 1, 2014): 1; http://www.timesofisrael.com/cabinet-authorizes-purchase-of-14-f-35-fighter-jets/; accessed April 15, 2017.
35. Jeremy Sharp, *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2018): 9–10; https://fas.org/sgp/crs/mideast/RL33222.pdf; accessed June 11, 2018.

36. See Nadav Burger, "F-35 Wings Production Line Inaugurated" (Jerusalem: Israel Air Force, June 11, 2014): 1–2; http://www.iaf.org.il/4414-43509-en/IAF.aspx; accessed April 15, 2017; and "Israel Orders 14 More F-35 Stealth Warplanes," *Globus: Israel's Business Arena* (February 22, 2015): 1; http://www.globes.co.il/en/article-israel-orders-14-more-f-35-stealth-warplanes-1001012189; accessed April 15, 2017.
37. See Yaakov Lapin, "The F-35 Joint Strike Fighter Aircraft: What it Brings to the IAF" (Jerusalem: Begin-Sadat Center for Strategic Studies, 2017): 1; https://besacenter.org/wp-content/uploads/2017/10/629-F35-Aircraft-Lappin-final-2.pdf; accessed January 4, 2018; and "Israel's F-35 Joint Strike Fighters Officially Ready for Action," *Sputnik News* (December 6, 2017): 1; https://sputniknews.com/military/201712061059767794-israel-f-35-ready-for-action/; accessed January 4, 2018.
38. Anna Ahronheim, "Israeli Air Force Commander Maj.-Gen. Amikam Norkin Speaks About Israel's Use of the F-35 (IDF Spokesperson's Unit) Adir Stealth Fighter Jet," *The Jerusalem Post* (May 22, 2018): 1–2; https://www.jpost.com/Israel-News/IAF-commander-Israel-first-to-use-F-35-jet-in-combat-558030; accessed May 23, 2018.
39. See Alessandro Marone, "Italy and the F-35: Rationales and Cost," *International Journal*, 68 (1) (Winter 2012–13): 31–32; https://doi.org/10.1177/002070201306800104; U.S. Department of State, *Treaties and Other International Acts Series 02-717.1*, *Defense: Joint Strike Fighter Program: Agreement Between the United States and Italy Supplementing the Memorandum of Understanding of January 17, 2001* (Washington, DC: Department of State, 2012); http://purl.fdlp.gov/GPO/gpo39829; accessed April 16, 2017; and Michele Nones, Giovanni Gasparini, and Alessandro Marrone, *Europe and the F-35 Joint Strike Fighter (JSF) Program* (Rome: Istituto Affari Internazionali, 2009): 74; http://www.iai.it/sites/default/files/quaderni_e_16.pdf; accessed April 16, 2017.
40. See Marone, 41–48; and Guy Dinmore, "Italy to Slash F-35 Order to 90 Aircraft," *Financial Times* (February 16, 2012): 15.
41. "Italian Lawmakers Back Cuts to JSF Purchase," *JSFNeuws.nl* (March 19, 2014): 1; http://www.jsfnieuws.nl/?p=1095; accessed April 16, 2017.
42. See Lockheed-Martin, "First-Ever Italian F-35A Rolls Out of Cameri, Italy, Production Facility" (Fort Worth: Lockheed-Martin, March 8, 2015): 1–2; https://www.f35.com/news/detail/first-ever-italian-f-35a-rolls-out-of-cameri-italy-production-facility; accessed April 16, 2017; and Vincenzo Camparini, Tomasso de Zan, Alessandro Morone, et al., *The Role of Italian Fighter Aircraft in Crisis Management Operations: Trends and Needs* (Rome: Istituto Affari Internationali, 2014): 87–128; http://www.iai.it/sites/default/files/iairp_16.pdf; accessed April 16, 2017.

43. See Lockheed Martin, "Amendola Air Base: Italy's First Operational F-35 Base" (Fort Worth: Lockheed Martin, 2017): 1; https://www.f35.com/about/who-is-flying/amendola; accessed April 16, 2017; and Italy, Ministry of Defense, *Multiyear Defense Programmatic Document for 2016–2018* (Rome: Ministry of Defense, 2016): 25–28; http://www.difesa.it/Content/Documents/DPP/DPP_2016_2018.pdf#search=joint%20strike%20fighter; accessed April 16, 2017.
44. See Dave Majumdar, "This Country Just Assembled a Lockheed Martin F-35B Joint Strike Fighter (And It's a Big Deal)," *The National Interest* (May 5, 2017): 1–3; http://nationalinterest.org/blog/the-buzz/county-just-assembled-lockheed-martin-f-35b-joint-strike-20542; accessed January 4, 2018; and "Italian Work Shortfall on F-35 Program Worsens," *Defense-Aerospace.com* (May 9, 2017): 2–3; http://www.defense-aerospace.com/articles-view/feature/5/183491/italian-work-on-f_35-program-falls-further.html; accessed December 4, 2017.
45. PriceWaterhouseCooper, *Italian F-35 Lightning II Program Economic Impact Assessment* (Rome: PriceWaterhouseCooper, 2014): 14–17; https://a855196877272cb14560-2a4fa819a63ddcc0c289f9457bc3ebab.ssl.cf2.rackcdn.com/14220/pwc_-_economic_impact_study_of_italian_f-35_program.pdf; accessed April 16, 2017.
46. See Francesco Tosato, *The F-35 Program From the Italian Perspective* (Rome: Centro Studi Internazionali, 2014): 31; http://www.sldinfo.com/wp-content/uploads/2014/10/Program_F-35_Italian_perspective1.pdf; accessed April 16, 2017; Italy, Ministry of Defense, *The General Directorate of Armaments* (Rome: Ministry of Defense, 2009): 96–99; http://www.difesa.it/SGD-DNA/InfoCom/Pubblicazioni/DPI/11DPI2009-sgd.pdf; accessed April 16, 2017; and Hartung, *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft*, 10–18.
47. See Japan, Ministry of Defense, *Chinese Activities Surrounding Japan's Airspace* (Tokyo: Ministry of Defense, 2013): 1–8; http://www.mod.go.jp/e/d_act/ryouku/index.html; accessed April 17, 2017; "Japan Jet Scrambles Near Cold War Record," *BBC News* (April 16, 2015): 1; http://www.bbc.com/news/world-asia-32330096; accessed April 17, 2017; Japan, Ministry of Defense, *Statistics on Scrambles During the First Quarter of FY2016* (Tokyo: Ministry of Defense, 2016): 1–5; http://www.mod.go.jp/js/Press/press2016/press_pdf/p20160705_02.pdf; accessed April 17, 2017; and Ibid., *Statistics on Scrambles Through Fiscal Year 2016* (Tokyo: Ministry of Defense, 2017): 1–15; http://www.mod.go.jp/js/Press/press2017/press_pdf/p20170413_02.pdf; accessed January 4, 2018.

48. See Astushi Tago and Srdjan Vucetic, "The 'Only Choice': Canadian and Japanese F-35 Decisions Compared," *International Journal*, 68 (4) (Winter 2012–13): 139; https://doi.org/10.1177/002070201306800109; Japan, Ministry of Defense, "Press Conference by the Defense Minister" (Tokyo: Ministry of Defense, December 20, 2011): 1–3; http://www.mod.go.jp/e/press/conference/2011/12/20.html; accessed April 17, 2017; and Ibid., *Defense of Japan 2012* (Tokyo: Ministry of Defense, 2012): 151–157; http://www.mod.go.jp/e/publ/w_paper/e-book/2012/index.html; accessed April 17, 2017.
49. See Ibid., 139–140, 147; Douglas Barrie and Robert Wall, "Starters Orders," *Aviation Week and Space Technology*, 171 (21) (December 7, 2009): 37; Bradley Perrett and Francis Leithen, "Skill-Preserver," *Aviation Week and Space Technology*, 173 (15) (April 25, 2011): 35.
50. Bradley Perrett, Amy Butler, Guy Norris, and Bill Sweetman, "Not Just Japan," *Aviation Week and Space Technology*, 173 (45) (December 19, 2011): 29.
51. Perrett and Butler, "Catalyst for Change," *Aviation Week and Space Technology*, 174 (1) (January 2, 2012): 26.
52. Bill Sweetman, "Many on Many," *Aviation Week and Space Technology*, 176 (4) (February 3, 2014): 66–68.
53. Perrett, "TRDI's Baby," *Aviation Week and Space Technology*, 176 (25) (July 21, 2014): 32.
54. Japan, Ministry of Defense, *Defense Programs and Budget of Japan: Overview of FY 2015 Budget* (Tokyo: Ministry of Defense, 2015): 5; http://www.mod.go.jp/e/d_budget/pdf/270414.pdf; accessed April 17, 2017.
55. U.S. Air Force, Misawa Air Base, "F-35 Lightning II Demonstration Comes to Misawa" (Misawa AFB, Japan: September 29, 2014): 1; http://www.misawa.af.mil/News/Article-Display/Article/773406/f-35-lightning-ii-demonstration-comes-to-misawa/; accessed April 17, 2017.
56. See Japan, Ministry of Defense, "Rollout Ceremony for the ASDF's First F-35A" (Tokyo: Ministry of Defense, 2016): 1; http://www.mod.go.jp/e/jdf/no82/specialfeature.html; accessed April 17, 2017; Ibid., *Defense of Japan 2016* (Tokyo: Ministry of Defence, 2016): 4–6, 50–56, 76–78, 189; http://www.mod.go.jp/e/publ/w_paper/2016.html; accessed April 17, 2017; *IISS Military Balance* (London: International Institute for Strategic Studies, 2017): 555; and Tim Kelly and Nobuhiro Kubo, "Japan Lawmakers Want First Strike Options as North Korea's Missile Threat Grows," *Reuters* (March 8, 2017): 1–3; http://www.businessinsider.com/r-as-north-korea-missile-threat-grows-japan-lawmakers-argue-for-first-strike-options-2017-3; accessed April 17, 2017.

57. Dave Majumdar, "Japan Just Built Its Very First F-35 Joint Strike Fighter," *The National Interest* (June 5, 2017): 1–3; http://nationalinterest.org/blog/the-buzz/japan-just-built-its-very-first-f-35-joint-strike-fighter-21018; accessed January 4, 2018; and Lockheed Martin, "JASDF's Next Generation Fighter" (Fort Worth: Lockheed Martin, 2017): 1; https://www.f35.com/global/participation/japan; accessed April 17, 2017.
58. See "Japan's Next F-X Fighters: F-35 Wins Round One," *Defense Industry Daily* (December 4, 2017): 4; http://www.defenseindustrydaily.com/f22-raptors-to-japan-01909/; accessed January 4, 2018; and Amy Butler, "Fight and Train," *Aviation Week and Space Technology*, 175 (45) (December 30, 2013): 61.
59. See Clay Dillow, "Japan Gets Serious About Building its Own Stealth Fighter," *Fortune* (March 24, 2016): 1–2; http://fortune.com/2016/03/24/japan-building-stealth-fighter/; accessed January 5, 2018; Gareth Jennings, "Japan Rolls Out First Domestically Built F-35," *Jane's Defence Weekly* (June 5, 2017); 1–2; and Lockheed Martin, "JASDF's Next Generation Fighter" (Fort Worth: Lockheed Martin, 2017): 1; https://www.f35.com/global/participation/japan; accessed April 17, 2017.

References

"Adir Who?: Israel's F-35i Stealth Fighters." *Defense Industry Daily* (November 18, 2014): 2.

Ahronheim, Anna. "Israeli Air Force Commander Maj.-Gen. Amikam Norkin Speaks About Israel's Use of the F-35 (IDF Spokesperson's Unit) Adir Stealth Fighter Jet." *The Jerusalem Post* (May 22, 2018): 1–2. https://www.jpost.com/Israel-News/IAF-commander-Israel-first-to-use-F-35-jet-in-combat-558030. Accessed May 23, 2018.

Allison, George. "Typhoon Uses Cannon in Combat." *UK Defence Journal* (June 6, 2016): 1–2. https://ukdefencejournal.org.uk/typhoon-uses-cannon-combat/. Accessed January 4, 2018.

Azulai, Yuval. "Knesset Finance C'ttee Approves F-35 Deal." *Globes: Israel's Business Arena* (September 20, 2010): 1. http://web.archive.org/web/20141031070436/http://www.globes.co.il/en/article-1000589810. Accessed April 15, 2017.

Barrie, Douglas, and Robert Wall. "Starters Orders." *Aviation Week and Space Technology*, 171 (21) (December 7, 2009): 37.

Ben-David, Alon, Amy Butler, and Robert Wall. "Wire Transfer: U.S, Israel Strike F-35 Technology Deal." *Aviation Week and Space Technology*, 173 (24) (July 4, 2011): 22.

Burger, Nadav. "F-35 Wings Production Line Inaugurated" (Jerusalem: Israel Air Force, June 11, 2014): 1–2. http://www.iaf.org.il/4414-43509-en/IAF.aspx. Accessed April 15, 2017.

Butler, Amy. "Fight and Train." *Aviation Week and Space Technology*, 175 (45) (December 30, 2013): 61.

Camparini, Vincenzo, Tomasso de Zan, Alessandro Morone, et al. *The Role of Italian Fighter Aircraft in Crisis Management Operations: Trends and Needs* (Rome: Istituto Affari Internationali, 2014): 87–128. http://www.iai.it/sites/default/files/iairp_16.pdf. Accessed April 16, 2017.

Cohen, Zachary. "U.S. F-35 Fighter Jets Arrive in Japan Ahead of Trump Visit." *CNN Politics* (October 31, 2017): 1–4. http://www.cnn.com/2017/10/31/politics/us-f-35-fighter-jets-arrive-japan/index.html. Accessed January 4, 2018.

"Contracts and Key Events 2011–2014." *Defense Industry Daily* (November 18, 2014): 4.

Dassault Aviation. *Rafale: The Omnirole Fighter* (Paris: Dassault Aviation, 2015a): 9, 12, 16, 18–19. http://www.dassault-aviation.com/wp-content/blogs.dir/2/files/2015/02/4-Defense-2015.zip. Accessed April 11, 2017.

———. "Signing Ceremony of the Sales Contract for Rafale to Egypt, 2015/02/16" (Paris: Dassault Aviation, 2015b): 1. http://www.dassault-aviation.tv/signing-ceremony-of-the-sales-contract-for-rafale-to-egypt-1150-en.html. Accessed April 10, 2017.

Davis, Ian, and Emma Mayhew. *What Happens When a White Elephant Meets a Paper Tiger?: The Prospective Sale of Eurofighter Typhoon Aircraft to Saudi Arabia and the EU Code of Conduct on Arms Exports* (London: British American Security Information Council, 2005). https://www.files.ethz.ch/isn/17188/BASIC%20PAPERS.pdf. Accessed June 11, 2018.

Danish Defence. *Facts and Figures: The Danish Armed Forces* (Copenhagen: Danish Defence, 2011): 36. http://www.fmn.dk/eng/allabout/Documents/TheDanishDefenceAgrement2013-2017english-version.pdf. Accessed April 12, 2017.

Denmark. Rigsrevisionen. *Report to the Public Accounts Committee on the Basis for Possible Acquisition of Combat Aircraft* (Copenhagen: Rigsrevisionen, 2009): 24, 28, 38. http://uk.rigsrevisionen.dk/media/1887782/9-2008.pdf. Accessed April 12, 2017.

Denmark. Ministry of Defence. *Danish Defence Agreement, 2013–2017* (Copenhagen: Ministry of Defence, 2012): 11. http://www.fmn.dk/eng/allabout/Documents/TheDanishDefenceAgrement2013-2017english-version.pdf. Accessed April 12, 2017.

———. *Executive Summary: Type Selection of Denmark's New Fighter Aircraft: Evaluations of Eurofighter, Joint Strike Fighter and Super Hornet* (Copenhagen: Ministry of Defence, 2016): 4–9. http://www.fmn.dk/temaer/kampfly/

Documents/type-selection-denmarks-new-fighter-aircrafts-english-summary5.pdf. Accessed April 12, 2017.
Dillow, Clay. "Japan Gets Serious About Building Its Own Stealth Fighter." *Fortune* (March 24, 2016): 1–2. http://fortune.com/2016/03/24/japan-building-stealth-fighter/. Accessed January 5, 2018.
Dinmore, Guy. "Italy to Slash F-35 Order to 90 Aircraft." *Financial Times* (February 16, 2012): 15.
Eurofighter Typhoon. *Technical Guide* (Munich: Eurofighter, 2013): 50. www.eurofighter.com/downloads/TecGuide.pdf. Accessed April 11, 2017.
———. *About Us* (Munich: Eurofighter, 2015): 1. http://www.eurofighter.com/about-us. Accessed April 11, 2017.
———. *Customers* (Munich: Eurofighter, 2017): 1. https://www.eurofighter.com/customers. Accessed April 11, 2017.
Foucheaux, Dorothée. *French Hard Power: Living on the Strategic Edge* (Washington, DC: American Enterprise Institute, 2014). http://www.aei.org/wp-content/uploads/2014/02/-french-hard-power-living-on-the-strategic-edge_162239575985.pdf. Accessed April 10, 2017.
Francis, Leithen. "TRDI's Baby." *Aviation Week and Space Technology*, 176 (25) (July 21, 2014): 32.
Francis, Leithen, and Perrett Bradley. "Skill-Preserver." *Aviation Week and Space Technology*, 173 (15) (April 25, 2011): 35.
Fulghum, David A., and Robert Wall. "Israel Nears Decision on F-35 Participation." *Aviation Week and Space Technology*, 156 (21) (May 27, 2002): 48–49.
Fulghum, David A., Robert Wall, and Barry Douglas. "Never Ending War." *Aviation Week and Space Technology*, 167 (24) (December 17, 2007): 48–50.
"Gripen Multirole Fighter Aircraft, Sweden." *Air Force Technology* (2015); 1. http://www.airforce-technology.com/projects/gripen/. Accessed April 11, 2017.
Hartung, William D. *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft* (Washington, DC: Center for International Policy, 2014): 17. http://www.ciponline.org/images/uploads/publications/Hartung_IPR_0114_F-35_Promising_the_Sky_Updated.pdf. Accessed April 12, 2017.
Hickey, Dennis V. "Dilemmas for US Strategy: Imbalance in the Taiwan Strait." *Parameters*, 43 (3) (Autumn 2013): 43–53.
"IAI Seeks Role on JSF." *Aviation Week and Space Technology*, 155 (25) (December 17, 2001): S12.
IISS Military Balance (London: International Institute for Strategic Studies, 2017).
Israel. Ministry of Foreign Affairs. "Cabinet Communique" (Jerusalem: Ministry of Foreign Affairs, September 19, 2010): 1. http://mfa.gov.il/MFA/PressRoom/2010/Pages/Cabinet-communique-19-Sep-2010.aspx. Accessed April 15, 2017.

"Israel Orders 14 More F-35 Stealth Warplanes." *Globus: Israel's Business Arena* (February 22, 2015): 1. http://www.globes.co.il/en/article-israel-orders-14-more-f-35-stealth-warplanes-1001012189. Accessed April 15, 2017.

"Israel's F-35 Joint Strike Fighters Officially Ready for Action." *Sputnik News* (December 6, 2017): 1. https://sputniknews.com/military/201712061059767794-israel-f-35-ready-for-action/. Accessed January 4, 2018.

"Italian Lawmakers Back Cuts to JSF Purchase." *JSF Neuws.nl* (March 19, 2014): 1. http://www.jsfnieuws.nl/?p=1095. Accessed April 16, 2017.

"Italian Work Shortfall on F-35 Program Worsens." *Defense-Aerospace.com* (May 9, 2017): 2–3. http://www.defense-aerospace.com/articles-view/feature/5/183491/italian-work-on-f_35-program-falls-further.html. Accessed January 4, 2018.

Italy. Ministry of Defense. *General Directorate of Armaments* (Rome: Ministry of Defense, 2009): 96–99. http://www.difesa.it/SGD-DNA/InfoCom/Pubblicazioni/DPI/11DPI2009-sgd.pdf. Accessed April 16, 2017.

———. *Multiyear Defense Programmatic Document for 2016–2018* (Rome: Ministry of Defense, 2016): 25–28. http://www.difesa.it/Content/Documents/DPP/DPP_2016_2018.pdf#search=joint%20strike%20fighter. Accessed April 16, 2017.

"Japan Jet Scrambles Near Cold War Record." *BBC News* (April 16, 2015): 1. http://www.bbc.com/news/world-asia-32330096. Accessed April 17, 2017.

Japan. Ministry of Defense. "Press Conference by the Defense Minister" (Tokyo: Ministry of Defense, December 20, 2011): 1–3. http://www.mod.go.jp/e/press/conference/2011/12/20.html. Accessed April 17, 2017.

———. *Defense of Japan 2012* (Tokyo: Ministry of Defense, 2012): 151–157. http://www.mod.go.jp/e/publ/w_paper/e-book/2012/index.html. Accessed April 17, 2017.

———. *Defense Programs. Chinese Activities Surrounding Japan's Airspace* (Tokyo: Ministry of Defense, 2013): 1–8. http://www.mod.go.jp/e/d_act/ryouku/index.html. Accessed April 17, 2017.

———. *Defense Programs and Budget of Japan: Overview of FY 2015 Budget* (Tokyo: Ministry of Defense, 2015): 5. http://www.mod.go.jp/e/d_budget/pdf/270414.pdf. Accessed April 17, 2017.

———. *Defense of Japan 2016* (Tokyo: Ministry of Defence, 2016a): 4–6, 50–56, 76–78, 189. http://www.mod.go.jp/e/publ/w_paper/2016.html. Accessed April 17, 2017.

———. "Rollout Ceremony for the ASDF's First F-35A" (Tokyo: Ministry of Defense, 2016b): 1. http://www.mod.go.jp/e/jdf/no82/specialfeature.html. Accessed April 17, 2017.

———. *Statistics on Scrambles During the First Quarter of FY2016* (Tokyo: Ministry of Defense, 2016c): 1–5. http://www.mod.go.jp/js/Press/press2016/press_pdf/p20160705_02.pdf. Accessed April 17, 2017.

———. *Statistics on Scrambles Through Fiscal Year 2016* (Tokyo: Ministry of Defense, 2017): 1–15. http://www.mod.go.jp/js/Press/press2017/press_pdf/p20170413_02.pdf. Accessed January 4, 2018.

"Japan's Next F-X Fighters: F-35 Wins Round One." *Defense Industry Daily* (December 4, 2017): 4. http://www.defenseindustrydaily.com/f22-raptors-to-japan-01909/. Accessed January 4, 2018.

Jennings, Gareth. "Japan Rolls Out First Domestically Built F-35." *Jane's Defence Weekly* (June 5, 2017): 1–2.

Keller, Patrick. *Challenges for European Defense Budgets After the Economic Crisis* (Washington, DC: American Enterprise Institute, 2011). https://www.defencetalk.com/challenges-for-european-defense-budgets-after-the-economic-crisis-35589/. Accessed June 8, 2018.

Kelly, Tim, and Nobuhiro Kubo. "Japan Lawmakers Want First Strike Options as North Korea's Missile Threat Grows." *Reuters* (March 8, 2017): 1–3. http://www.businessinsider.com/r-as-north-korea-missile-threat-grows-japan-lawmakers-argue-for-first-strike-options-2017-3. Accessed April 17, 2017.

Lapin, Yaakov. "The F-35 Joint Strike Fighter Aircraft: What It Brings to the IAF" (Jerusalem: Begin-Sadat Center for Strategic Studies, 2017): 1. https://besacenter.org/wp-content/uploads/2017/10/629-F35-Aircraft-Lappin-final-2.pdf. Accessed January 4, 2018.

Lewis, Avi. "Cabinet Authorizes Purchase of 14 F-35 Fighter Jets." *Times of Israel* (December 1, 2014): 1. http://www.timesofisrael.com/cabinet-authorizes-purchase-of-14-f-35-fighter-jets/. Accessed April 15, 2017.

Lockheed Martin. "Denmark: Future Air Power" (Fort Worth: Lockheed Martin, 2015a): 3–4. https://www.f35.com/global/participation/denmark. Accessed April 12, 2017.

———. "First-Ever Italian F-35A Rolls Out of Cameri, Italy, Production Facility" (Fort Worth: Lockheed-Martin, March 8, 2015b): 1–2. https://www.f35.com/news/detail/first-ever-italian-f-35a-rolls-out-of-cameri-italy-production-facility. Accessed April 16, 2017.

———. "Lockheed Martin and Israel Celebrate Rollout of Israel's First F-35 'Adir'." *Lockheed Martin* (June 22, 2016). https://www.f35.com/news/detail/lockheed-martin-and-israel-celebrate-rollout-of-israels-first-f-35-adir. Accessed August 14, 2018.

———. "Amendola Air Base: Italy's First Operational F-35 Base" (Fort Worth: Lockheed Martin, 2017a): 1. https://www.f35.com/about/who-is-flying/amendola. Accessed April 16, 2017.

———. "JASDF's Next Generation Fighter" (Fort Worth: Lockheed Martin, 2017b): 1. https://www.f35.com/global/participation/japan. Accessed April 17, 2017.

Majumdar, Dave. "Japan Just Built Its Very First F-35 Joint Strike Fighter." *The National Interest* (June 5, 2017a): 1–3. http://nationalinterest.org/blog/

the-buzz/japan-just-built-its-very-first-f-35-joint-strike-fighter-21018. Accessed January 4, 2018.

———. "This Country Just Assembled a Lockheed-Martin F-35B Joint Strike Fighter (And It's a Big Deal)." *The National Interest* (May 5, 2017b): 1–3. http://nationalinterest.org/blog/the-buzz/county-just-assembled-lockheed-martin-f-35b-joint-strike-20542. Accessed January 4, 2018.

Marone, Alessandro. "Italy and the F-35: Rationales and Cost." *International Journal*, 68 (1) (Winter 2012–13): 31–32. https://doi.org/10.1177/0020701306800104.

McIntosh, Andrew. "Boeing's Dogfight with Denmark over $3 Billion Fighter Jet Contract Lands in Court." *Puget Sound Business Journal* (March 2, 2017): 1–3. http://www.bizjournals.com/seattle/news/2017/03/02/boeings-denmark-lockheed-martin-fighter-jet.html. Accessed April 12, 2017.

Nones, Michele, Givanni Gasparini, and Alessandro Marone. *Europe and the F-35 Joint Strike Fighter (JSF) Program* (Rome: Istituto Affari Internazionali, 2009): 74. http://www.iai.it/sites/default/files/quaderni_e_16.pdf. Accessed April 16, 2017.

O'Dwyer, Gerard, and Aaron Mehta. "Danish Firms Want Bigger Slice of JSF Pie." *Defense News* (October 6, 2012): 1–4. http://www.combataircraft.com/en/News/2012/10/07/Danish-Firms-Want-Bigger-Slice-of-JSF-Pie/. Accessed April 12, 2017.

Perrett, Bradley, and Amy Butler. "Catalyst for Change." *Aviation Week and Space Technology*, 174 (1) (January 2, 2012): 26.

Perrett, Bradley, Amy Butler, Guy Norris, and Bill Sweetman. "Not Just Japan." *Aviation Week and Space Technology*, 173 (45) (December 19, 2011): 29.

Poms, Shani. "Cornerstone Laying for F-35 Squadron Release Date" (Jerusalem: Israel Air Force, November 11, 2014): 1–2. http://www.iaf.org.il/4415-43545-en/IAF.aspx. Accessed April 15, 2017.

PriceWaterhouseCooper. *Italian F-35 Lightning II Program Economic Impact Assessment* (Rome: PriceWaterhouseCooper, 2014): 14–17. https://a855196877272cb14560-2a4fa819a63ddcc0c289f9457bc3ebab.ssl.cf2.rackcdn.com/14220/pwc_-_economic_impact_study_of_italian_f-35_program.pdf. Accessed April 16, 2017.

"Rafale Multirole Combat Fighter, France." *Air Force Technology* (2015): 1–2. http://www.airforce-technology.com/projects/rafale/. Accessed April 10, 2017.

Rasmussen, Mikkel Vedby, and Hendrik Ø Breitenbauch. *Denmark's Need for Fighter Aircraft: A Strategic Analysis of the Future Need for Danish Fighter Aircraft* (Copenhagen: University of Copenhagen Centre for Military Studies, 2007). http://cms.polsci.ku.dk/english/pdf/need_for_fighter_aircraft.pdf. Accessed April 12, 2017.

Ringsmose, Jen. "Investing in Fighters and Alliances: Norway, Denmark, and the Bumpy Road to the Joint Strike Fighter." *International Journal*, 68 (1) (Winter 2012–13): 96. https://doi.org/10.1177/002070201306800107.

Saab Group. "Gripen Users" (Stockholm: Saab Group, 2014): 2. http://saab.com/air/gripen-fighter-system/gripen/gripen/users-gripen/. Accessed April 11, 2017.

———. *Gripen NG: Performance, Facts, and Figures* (Stockholm: Saab Group, 2015): 3. http://saab.com/globalassets/commercial/air/gripen-fighter-system/gripen-ng/technical-brochure-gripen-ng-english-ver.2-jan-2015_low.pdf. Accessed April 11, 2017.

Scott-Smith, Giles, and Max Smeets. "Noblesse Oblige: The Transatlantic Security Dynamic and Dutch Involvement in the Joint Strike Fighter Program," *International Journal*, 68 (1) (Winter 2012–13): 49–51. https://doi.org/10.1177/002070201306800105.

Sharp, Jeremy M. *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2008): 2. http://emetnews.org/documents/us-foreign-aid-to-israel-2008.pdf. Accessed April 15, 2017.

———. *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2010): 7. http://emetnews.org/documents/US-Foreign-Aid-to-Israel.pdf.

———. *U.S. Foreign Aid to Israel* (Washington, DC: Library of Congress, Congressional Research Service, 2016): 9–10. https://fas.org/sgp/crs/mideast/RL33222.pdf. Accessed June 11, 2018.

Sweden. Ministry of Defence. "Budget Reinforcement to the Swedish Armed Forces' Regimental- and Air Surveillance Capabilities" (Stockholm: Ministry of Defence, 2014): 1–2. http://www.government.se/articles/2014/10/budget-reinforcement-to-the-swedish-armed-forces-regimental%2D%2Dand-air-surveillance-capabilities/. Accessed March 11, 2017.

———. "Speech by Defense Minister Peter Hultqvist at the Unveiling of the First Gripen E Test Aircraft" (Stockholm: Ministry of Defence, 2016): 1–3. http://www.government.se/speeches/2016/05/speech-by-defence-minister-peter-hultqvist-at-the-unveiling-of-the-first-gripen-e-test-aircraft/. Accessed April 11, 2017.

———. "Peter Hultqvist Visits the Hungarian Defence Minister" (Stockholm: Ministry of Defence, 2017): 1. http://www.government.se/articles/2017/09/peter-hultqvist-visits-the-hungarian-defence-minister/. Accessed January 4, 2018.

Sweetman, Bill. "Many on Many." *Aviation Week and Space Technology*, 176 (4) (February 3, 2014): 66–68.

———. "JSF's Year Ahead." *Aviation Week and Space Technology*, 177 (1) (January 15, 2015): 20.

Tago, Astushi, and Srdjan Vucetic. "The 'Only Choice': Canadian and Japanese F-35 Decisions Compared." *International Journal*, 68 (4) (Winter 2012–13): 139. https://doi.org/10.1177/002070201306800109.

Tosato, Francesco. *The F-35 Program From the Italian Perspective* (Rome: Centro Studi Internazionalei, 2014): 31. http://www.sldinfo.com/wp-content/uploads/2014/10/Program_F-35_Italian_perspective1.pdf. Accessed April 16, 2017.

"Transforming Typhoon." *Aerospace America*, 52 (1) (January 2014): 4–5.

U.S. Air Force. Misawa Air Base. "F-35 Lightning II Demonstration Comes to Misawa" (Misawa AFB, Japan: September 29, 2014): 1. http://www.misawa.af.mil/News/Article-Display/Article/773406/f-35-lightning-ii-demonstration-comes-to-misawa/. Accessed April 17, 2017.

U.S. Department of Defense. "Hagel, Yaalon Finalize New Israeli Military Capabilities" (Washington, DC: U.S. Department of Defense, April 22, 2013): 1. http://archive.defense.gov/news/newsarticle.aspx?id=119838. Accessed April 15, 2017.

U.S. Department of State. *Treaties and Other International Acts Series 02-717-1, Defense: Joint Strike Fighter Program: Agreement Between the United States and Italy Supplementing the Memorandum of Understanding of January 17, 2001* (Washington, DC: Department of State, 2012). http://purl.fdlp.gov/GPO/gpo39829. Accessed April 16, 2017. www.metric-conversions.org/.

"What Next for Typhoon." *Combat Aircraft* (November 30, 2017): 1. http://www.combataircraft.net/2017/11/30/what-next-for-typhoon/. Accessed January 4, 2018.

CHAPTER 9

JSF and the Netherlands, Norway, Singapore, South Korea, Taiwan, and Turkey

The Netherlands

On December 12, 1996, the Dutch government of Labour Party Minister-President Wim Kok began searching for a replacement to the Royal Netherlands Air Force (RNAF) main strike fighter, the F-16. Dutch participation in the JSF has involved collaboration between governmental, industrial, and military commitment to keep the project on task even with increasing parliamentary opposition and budget cuts. The RNAF wants access to cutting-edge US military technology to remain a key player in NATO decision-making and Dutch industry has wanted to bring its expertise to this project to enhance national economic development.[1]

An RFI for an F-16 replacement was issued by the Dutch Government on June 3, 1999, focusing on Dassault Rafale, Eurofighter Typhoon, an updated General Dynamics F-16, Lockheed Martin's JSF, McDonnell-Douglas F/A-18 E/F Super Horner, and Saab-Gripen. Criteria specified by The Hague for this new aircraft included responsiveness, all-weather durability, strategic and tactical mobility, logistical independence, flexibility, multi-functionality, and information provision along with opportunities for Dutch industry to provide essential developmental and production components.[2]

An analysis of Dutch involvement with the JSF reveals their program and accompanying political controversy initially went through three phases covering 1996–2000, 2001–2002, and 2006–2008. Protracted Dutch involvement in JSF involved the multi-partisan coalition characteristics of

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_9

Dutch governments with parties from the center-right being more likely to support the JSF and parties from the center-left tending to be less supportive, though there could often be significant exceptions to this within these parties based on factors such as desiring to support Dutch aerospace workforce and industries and opposing costly and protracted defense spending which some saw as unnecessary in the immediate post-Cold War security environment.[3]

On February 9, 2002, the Dutch Cabinet decided to participate in the JSF program. This decision committed The Hague to purchase 85 JSFs beginning in 2010 with a budget allocation of €5.5 billon ($4.84 billion).[4] By early October 2003, Dutch firms had won JSF contracts worth $58 million through 2012 with companies such as Stork-Fokker, Thales, and Kleizen winning contracts to produce landing gear, in-flight refueling, cryogenic coolers, tooling, and wing components.[5]

During the 2006 Dutch election, a leading party suggested that the Netherlands withdraw from the JSF due to costs. However, Dutch industrial participation in the JSF at this time included more than 70 companies with contracts of $700 million and program advocates claimed the potential value of future JSF contracts would approach $8–10 billion.[6] Responding to this opposition party threat, the Dutch government signed an MOU with Lockheed Martin in November 14, 2006, committing to continued participation in the JSF even though a buying decision was not expected until 2009.[7]

A 2008 Rand Corporation report prepared for the Dutch Defense Ministry was mostly positive about that country's JSF acquisition process. It noted that appropriate suppliers for F-16 replacement aircraft were engaged from various competitors, that correct information on their capabilities was requested from them, that potential conflicts of interest were effectively documented and managed, and that JSF requirements were explicitly linked to Dutch political and military ambitions. Concerns expressed in this assessment were time limitations and late responses to assessment timetable tasks, suppliers not being provided the same information at the same time but receiving equal response submission time.[8]

A 2012 report by Holland's national auditor examined the costs which would be incurred if it decided to leave the JSF program. It mentioned that continuing the present policy of purchasing the JSF to replace the F-16 would impose major demands on Ministry of Defense funding and require the Defense Minister to make far-reaching choices about the composition and equipment for other military branches and the number of

JSFs to purchase. A second scenario in this report evaluated the consequences of withdrawing from the JSF's test phase. This section determined that this action would require keeping the F-16 in service until 2029; that paying for a test phase of its own would cost The Hague between €63 million and €318 million ($67–$341) million and that withdrawing from the JSF test phase would not be functionally, chronologically, or financially beneficial, and would produce delays, lower quality, and increased risks for personnel, aircraft, and operational capability.[9]

A third scenario in this report examined the possibility of the Netherlands withdrawing from the JSF and purchasing an off-the-shelf successor. This mentioned that withdrawing from the JSF would end Dutch influence on JSF development, would not lead to quicker replacement of the F-16, noted the uncertainty of other candidate aircraft's delivery time, and observed that such withdrawal would save the Netherlands €265 million ($284 million) but cost at least €405 million ($435 million) in addition to other unknown costs. The Court of Audit concluded that withdrawing from JSF would require RNAF to revise its operational deployment standards.[10]

A 2013 document by this agency criticized a Ministry of Defense claim that deploying four JSF could support Dutch ground forces in areas such as Afghanistan due to incomplete ministry calculations, uncertainty over whether negotiating joint national airspace protection with Belgium would produce intended operational savings, and mistakenly assuming that maintenance problems affecting the armed forces would not affect the JSF. It also noted that financial costs cannot be assured for a fighter aircraft expected to be in service after 2050 and that it approves of the government's formation of a 10% risk reserve for the JSF's investment and operational budgets.[11]

September 17, 2013, saw the Dutch Cabinet approve purchasing 37 F-35s. Defense Minister Jeanine Hennis-Plasschaert announced that the JSF was a key innovation for the military, pointing out the Netherlands' decreasing military ambitions and noting that future Dutch military operations would be shorter than previously possible. This approval came about due to the presence of a Labor and Liberal Party coalition government after the September 2012 elections. The decision was also made in an environment where The Hague's F-16 fleet, which once included 200 aircraft, had shrunk to fewer than 70 aircraft with an additional 10% cut in aircraft expected to be cut in 2014.[12]

On March 3, 2015, the Dutch Parliament approved an order of eight JSFs to be delivered in 2019. Jeanine Hennis-Plasschaert said, "We have reached the point of no return of the F-16." Three further batches of 8 aircraft will be ordered between 2016 and 2018 and a final 3 will be purchased in 2019, bringing the total to fleet to 35. These will be stationed with the RNAF's 322 Squadron at Leeuwarden and Volkel Air Bases and reach initial operational status in 2021. The total Dutch budget for the JSF is €3.87 billion ($4.32 billion) including €2.5 billion ($2.684 billion) for air frame purchases, nearly €100 million ($107 million) for spare parts, and €110 million ($118 million) for a flight simulator. The Defense Ministry mentioned JSF purchases could reach 37 if the total price is reduced or other costs remain below budget.[13]

On June 23, 2016, Hennis-Plasschaert and Economic Affairs Minister Henk Kemp testified before the Netherlands States General (Parliament) Standing Committees on Defense and Economic Affairs to discuss JSF developments. They informed legislators that JSF testing will continue until 2018 and that in 2019 the Netherlands may use the aircraft for training and operational purposes. Committee members noted that residents near the Leeuwarden and Volkel airbases had expressed concern about JSF noise and that the Netherlands Aerospace Center (NAC) has organized noise experience flights to enable local residents to determine noise levels for themselves and see if there are differences between the F-16 and JSF. Hennis-Plasschaert also announced that a €4.5 billion ($4.801.230 billion) investment budget and €270 million ($288.074 million) in annual operating costs have been earmarked for the F-16's replacement. The Hague intends to acquire eight JSF in 2020 and is working with the US Joint Program Office on a possible option to purchase several JSF over several years in an effort to reduce costs with actual cost reductions depending on the number of aircraft purchased and contract negotiation results. A December 12, 2016, report by the NAC determined that hardened airbases at Leeuwarden and Volkel were suitable for the JSF concerning gas emissions and temperatures and were not hazardous to base personnel. The March 15, 2017, election victory of incumbent Prime Minister Mark Rutte's coalition is not likely to change the Netherlands' commitment to the JSF.[14]

On November 30, 2017, State Secretary for Defense Barbara Visser informed the Dutch Parliament that the rising value of the dollar against the euro may create a situation in which the Netherlands does not have enough money to buy the last three JSFs it intends to purchase. Visser mentioned that the final decision on this purchase would be made in 2019.[15]

Dutch Industry JSF Participation: Dutch companies participating in JSF production include some of the companies laid out in Table 9.1.

Table 9.1 Dutch JSF contractors[16]

Fokker Eindhoven; Hoogerheide; Schiphol	Mobile flaps on the wings of the aircraft for controlling the ascent and descent of the aircraft
Philips Amsterdam, Eindhoven	F136 engine phase III; fan casing; rotor disk blades
SP Aerospace Geldrop	Arresting gear components for conventional and carrier aircraft; landing gear components
Stork Aerospace Schiphol	Aircraft and engine wiring harnesses
Thales Hengelo	Cryogenic coolers; electro-optic parts
Urenco Almelo	Liftfan driveshaft; power and thermal management components

Norway

During the late 1990s, Norway began considering replacing its air force's F-15 fighter fleet. It began a low-key aircraft competition involving an upgraded F-16 and the Eurofighter Typhoon. This competition never identified a winner though there was some evidence that the Air Force preferred the Eurofighter. It appears that Norwegian Defense Minister Bjørn Tore Godal decided Norway should wait for the JSF to mature before making a final decision. As of 2002, Norway was a Level 3 partner contributing $125 million.[17]

During Fall 2005, Norway's competition for an F-15 replacement fighter began when Prime Minister Jens Stoltenberg's Labour coalition government invited Dassault, Eurofighter, Lockheed Martin, and Saab to submit bids. The Norwegian government specified the top three criteria for this new fighter would be: operational requirements, life cycle costs, and potential Norwegian defense industry benefits. Oslo made no mention of political or strategic considerations in their procurement plans and in January 2007 Norway signed an MOU making it a participant in the JSF's Production, Sustainment, and Follow-On Development Phase.[18]

Norwegian political debate on the JSF became more open during summer and Fall 2008 with many political analysts believing Norway would select the Saab-Gripen due to assertive Swedish marketing. This course of action was favored by the Confederation of Norwegian Enterprise and the Norwegian Society of Engineers and Technologists who thought the Gripen would be more cost-effective. However, on November 20, 2008, Stoltenberg announced that Norway would select the JSF which it determined would be better operationally. The government also maintained that the JSF had cheaper life cycle costs than the Gripen and the Norwegian Storting (Parliament) approved the beginning of negotiations between the Defense Ministry and Lockheed Martin to approve acquiring 52 JSFs for Ministry and Lockheed Martin. On June 8, 2012, the Storting approved acquiring 52 JSFs for expected delivery between 2017 and 2024.[19]

Oslo's seriousness about providing JSF industrial opportunities for indigenous companies was further demonstrated by the government's February 2012 decision to establish a funding program for such participation to run from 2012 to 2015 with a budget of 50 million Norwegian Kroner ($8.8 million).[20] Once received, the Norwegian JSFs are expected to be deployed at central Norway's Ørland Air Base with Evenes Air Base serving as a smaller facility for quick reaction capabilities in the North against Russian incursions.[21]

The March 23, 2012, Norwegian Defense White Paper included the following assertions from Defense Minister Espen Barth Eide on why Norway chose the JSF and a protracted procurement process:

> Norway chose the F-35 in 2008 after a long and thorough process, and the aircraft will play a vital part in guaranteeing Norway's future ability to deter aggression and contribute to international peace and security. … We remain confident that the F-35 represents the best capability for the best value possible. The purpose of the adjusted procurement plan is to give the Norwegian Government greater financial freedom of manoeuvre during the years of the main procurement by spreading out the cost more evenly. We believe this new schedule better balances this concern with the introduction of a vital new capability to the Norwegian Armed Forces.[22]

On January 20, 2014, Norwegian Defense Minister Ine Eriksen Søreide met US JSF Program Head Lt. General Christopher Bogdan in Washington to discuss JSF cooperation between these two counties. Norway confirmed that the first 4 JSFs it purchased were to be delivered in the United States in 2015–2016 and that the total cost of the 52 JSFs Norway plans to purchase is 64 billion NOK ($8.067 billion).[23] On October 13, 2014, the Defense Ministry announced its proposal to increase defense spending by 3.4% in 2015 with much of this spending being allocated toward purchasing naval systems and the JSF and its Norwegian-produced Joint Strike Missile (JSM) system.[24] On April 16, 2015, Lockheed Martin announced that the first JSF for Norway was standing with weight on wheels for the first time at the Fort Worth assembly plant. This plane and a second JSF to be produced later in 2015 will initially be based at Arizona's Luke Air Force Base.[25]

On September 22, 2015, Søreide announced the rollout of Oslo's first JSF in Fort Worth. She noted that Norway had committed to purchasing 22 of 52 jets; that the Storting would reassess the requirement for the last 6 JSFs once the first 46 are delivered; that Norwegian pilots will train in 4 JSFs at Luke AFB; that the first JSF is expected to arrive in Norway in 2017; and that Initial Operating Capability will be achieved in 2019, full operating capability in 2025, and final deliveries will be completed in 2024. Kongsberg is also developing the JSM for Norway's JSF as part of its contract. The JSM is a long-range anti-ship and anti-surface missile which can be carried in the JSF's internal weapons bay which help preserve JSF's stealth characteristics for missions against highly advanced enemy air defenses. In December 2016, it was successfully tested by an F-16 at the Utah Test and Training Range.[26]

During a September 20, 2016, address at the Army Summit in Oslo, Søreide announced that Norway would increase its defense budget NOK 165 billion ($19.239.500 billion) over the next 20 years with at least NOK 7.2 billion ($839.540 million) of this occurring between 2017 and 2020. She went on to maintain that this supplemented JSF funding while contending that the JSF not only enhanced Air Force fighting power but also served as a force multiplier for the Navy and Army and that without airspace control Norway is vulnerable on land and sea. This funding increase is part of implementing the June 2016 Long-Term Defence Plan which noted the deteriorating security environment facing Norway since the 2012 Defence White Paper.[27]

On November 10, 2017, the first Norwegian JSFs arrived at Ørland Main Air Station in west central Norway. Welcoming these planes Prime Minister Erna Solberg stressed that acquiring the JSF was Norway's biggest single military investment which would give its military unprecedented capabilities. She also stressed that acquiring the JSF would enhance Norwegian interoperability with other NATO countries and that participating in this program gives Norway several billion kroner in defense contracting opportunities.[28]

Norwegian Industrial Participation: Norwegian companies are involved in producing various JSF components and expected to generate $4.7 billion in program benefits over the life of the program. In addition to the

Table 9.2 Norwegian JSF contractors[29]

Kitron ASA Arendal, Billingstad	Electronic test equipment for electronic warfare; integrated backplane assembly
Kongsberg Gruppen Kongsberg	Joint Strike Missile
Volvo Aero Norge Kongsberg	Intermediate case, F135 engine shaft

JSM, Norwegian contractors are working on giving their JSF drag chute capacity which includes a missionized pod on the JSF's rear upper surface facilitating JSF stoppage on short icy runways. Testing of this drag chute was occurring at Alaska's Eielson, AFB, in late 2017 and early 2018. Examples of these companies are shown in Table 9.2.

Singapore

This Southeast Asian city-state is another potential JSF purchaser though its involvement in this program has been more protracted and secretive than many other countries. In 2003, Singapore joined the JSF program as a Security Cooperation Participant. During 2007, Singapore's then Chief of Air Force Major General Ng Chee Khern announced that the JSF, along with the F-15SG, was a possible candidate to replace the Royal Singapore Air Force (RSAF) aging F-5 fleet. Testifying on March 12, 2013, at the Singapore's Parliament's Committee on Supply, Defence Minister Ng Eng Hen mentioned Singapore's intention to acquire new military platforms for the military with particular emphasis on the Air Force and Navy. Ng stressed that two RSAF combat air platforms are at mid-life or near the end of their expected operational life cycles and mentioned that the Defense Ministry was close to finishing evaluation of the JSF as a potential replacement for these fighters.[30]

As part of its national review progress, Ng, Parliamentary Foreign Affairs and Defence Committee Chair Lim Wee Kiak, Chief of Air Force Major General Hoo Cher Mou, and other senior Defence Ministry and RSAF officials saw demonstrations of the JSF by the US Marine Corps during a December 10, 2013, visit to the United States. As part of Exercise Forging Sabre in Phoenix, they saw RSAF fighters conduct operations against an enemy using F-15s and F-16s while also integrating strikes on static and moving targets with the Army's High Mobility Artillery Rocket Systems.[31]

Singapore may decide to purchase the F-35 due to its close security ties with the United States and economic affluence. This affluence is demonstrated by Singapore's estimated FY 2017 defense spending being S$ 14.206 billion ($10.630 billion).[32] However, a 2014 report notes that while Asia is a growing market for arms purchases, that the JSF is affordable only to a small number of countries, consequently leaving the market open to lower-cost jet fighter alternatives.[33]

On February 25, 2015, Lt. General Chris Bogdan, the US JSF program head, contended that Singapore was getting closer to purchasing the JSF. He went on to observe that Singapore had requested information on the conventional take-off and landing, short take-off and landing, and carrier variants of the JSF. In mid-2015, Singapore had not made a firm decision on purchasing the JSF.[34]

Singaporean national security policymakers are acutely aware of emerging trends in military aviation technology and strategic challenges facing the island nation situated in close proximity to the South China Sea. A 2016 article in *Pointer*, Singapore's professional military journal, noted:

> Technology has been and will continue to be a critical force multiplier for a small armed force like the SAF. We must continue to sustain technological collaboration with key strategic partners such as the US. This is critical considering the huge capital outlay for research and development to create highly advanced air platforms such as the F-15 and the Joint Strike Fighter (JSF). At the same time, we must strengthen our focus on our indigenous defence industry for capabilities unique to our operating requirements. This may be a function of adjusting investment allocation, as well as improving operations-technology integration to streamline collaboration between the SAF and the Defence Technology Community for more focused investments and bringing to fruition projects in the pipeline.[35]

However, on September 30, 2016, Defense Minister Ng said that while Singapore remains interested in the JSF, it does not expect to purchase it until 2030. He also stressed his belief that Singapore's existing F-15 and F-16 fleet could last another decade or two while maintaining that Singapore would not be influenced by South China Sea developments or Chinese military power. Singapore's FY 2017 budget of Singapore Dollars (SDG) $14.451 ($10,813.600 billion) is the second largest expenditure of that country's budget and it would be more than capable of financially sustaining some JSF purchases if it decides to.[36]

Singaporean JSF Industrial Participation Capacity

Although it has still not decided whether to participate in JSF, Singapore's aerospace industry would be more than capable of meeting the challenges and opportunities provided by contracting with Lockheed Martin and the JSF Program Office. Singapore has over 100 aerospace companies and contributes over one-fourth of the Asia-Pacific region's maintenance, repair, and overhaul output. During February 2012 and January 2013, Rolls-Royce and Pratt & Whitney opened or broke ground for new facilities covering capabilities such as engine assembly and testing, R&D, and blade and turbine disk manufacturing.

Since 2008, Singapore has hosted an annual air show which has become one of the world's three biggest airshows. The 2012 show attracted 45,000 visitors from 128 countries generating over $31 billion in approved deals. Singapore's aerospace industry employs approximately 19,800 workers; it has grown an average of 10% over the past two decades, and achieved a 2013 output of $8.7 billion. Specific examples of Singaporean aerospace companies potentially capable of fulfilling JSF contractual obligations include Bombardier Aerospace, Meggitt Aerospace Asia Pacific, National University of Singapore's Centre for Aerospace Engineering, Pratt & Whitney, RLC Engineering Group, Safran Electronics Asia, ST Aerospace, and Standard Aero.[37]

South Korea

South Korea remains an important arena of international security interest six decades after the end of the Korean War. Its biggest immediate security concern is the continuing threat from a nuclear-armed North Korea with large conventional forces. It is also adjacent to China and subject to Beijing's increasing geopolitical assertiveness along with similar behavior from Russia which also shares a border with North Korea. Some elements in South Korea remain concerned about Japan as a security challenge due to Japan's historical colonial dominance in South Korea and lingering resentment over World War II. Recent years have seen South Korea recognize the need to replace its F-4 Phantom and F-5 Tiger fighters after 2020. All of these developments prompted South Korea to begin looking for potential future fighter candidates and by 2011 this search focused on the F-15SE Silent Eagle, Eurofighter Typhoon, the JSF, and the indigenous South Korean KF-X fighter program.[38]

Security concerns Seoul must consider in making its next-generation fighter selection include its vulnerability to hidden North Korean artillery capable of inundating vast amounts of shells per minute on Seoul, the unknown number of North Korean nuclear warheads and their reliability when fired from hidden sites in that country's north, and having a deep strike capability to retaliate against North Korean targets. Consequently, this makes strike and survivability vital requirements for future South Korean fighters. Developing industrial opportunities for South Korean companies also factors into Seoul's decision-making.[39]

These aircraft have received criticism in South Korea as well. In February 2013, the Korean Institute for Defense Analyses (KIDA) (a Ministry of National Defense entity) said South Korea is technologically incapable of developing the KF-X; that the project is economically unviable; and that it would not be a successful export product. KIDA analyst Lee Juhyeong also mentioned KF-X development would cost over 10 trillion won ($9.2 billion) and cost more than twice as much as an imported aircraft.[40]

On March 29, 2013, DSCA notified Congress of the potential Foreign Military Sale to South Korea of 60 F-35 CTOL aircraft and associated equipment, parts, training, and logistical support for an estimated $10.8 billion. DSCA contended that this proposed sale would further US foreign and national security policy goals by meeting an allied country's legitimate security and defense needs.[41]

A major boost for the JSF came in late September 2013, when the Defense Acquisition Program Administration (DAPA) rejected the Boeing F-15SE as being unproven technologically despite its price competitiveness with the JSF and the Eurofighter which was also rejected. This decision effectively reopened South Korean fighter plane bidding with Defense Ministry spokesman Kim Min-Seok saying: "We need a capability to counter North Korea's asymmetric threats of nuclear weapons and missiles. … In the meantime, we need to catch up with the latest trend of aerospace technology worldwide centered around the fifth-generation fighter jets."[42]

On March 24, 2014, South Korea announced that it would purchase 40 JSF CTOL fighter planes with delivery expected in 2018 with Lockheed Martin and Pratt & Whitney being the prime contractors. The reported purchasing price was 7.34 trillion won ($6.79 billion) with pressure from military interests and the desire to integrate with the US Air-Sea Battle strategy being key factors in this decision. South Korea's 2014 Defense White Paper stressed the continuing conventional and military threat from North Korea and how Seoul needed to maintain a robust capability of forces including an Air Force allied with the United States to deter and defeat threats to national sovereignty.[43]

A January 2017 KIDA report noted that Seoul's defense spending that year was a record high 40.3 trillion won ($3.503.680 billion) representing a 4% increase over 2016. This increased spending was allotted to the JSF and other resources such as UAVs and ballistic missile defense in response to increasing North Korean nuclear tests along with anticipated increased maintenance costs for the JSF and other equipment.[44]

Although there may be uncertainty in South Korean politics following the March 2017 impeachment of President Park Geun-hye, the ongoing threat from North Korea is likely to keep Seoul committed to the JSF and to pursuing a somewhat more assertive military posture by the composition of a successor government of Moon Jae-In. This was demonstrated by a December 2017 media report that South Korea and Japan were considering putting the JSF on ships which would give these countries the ability to conduct deep strikes into a nuclear-armed North Korea. JSFs were used by the United States in a joint Korean Peninsula flyover with South Korean forces in late August 2017 as a warning to North Korea. Seoul may deploy the F-35B aboard a 14,000-ton warship scheduled for deployment in 2020.[45]

South Korean JSF Industrial Participation

Korea Aerospace Industries in Sacheon is the company most likely to benefit from potential JSF contract opportunities. Through 2013, the South Korean aerospace industries produced products worth $5.766 billion; this reached $7.859 billion by 2016, and was expected to reach $8.274 billion in 2017. Seoul is the tenth largest market for US aerospace exports with these exceeding $4.4 billion in 2015. These products were distributed to countries as diverse as the United States, France, Indonesia, the United Kingdom, Japan, and the United Arab Emirates. Military sales account for 60% of South Korean aerospace industries sales and this industry's workforce was 11,544 in 2014. Various combat aircraft have been produced by these industries including KB-1 trainers and a Korean version of the F-16.[46]

Table 9.3 shows additional potential South Korean beneficiaries from Seoul's decision to purchase the JSF in years to come.

Table 9.3 Potential South Korean JSF contractors[47]

DoDaam Systems Daejeon City	Simulator; avionics and support equipment.
Hanwha Gyeongnam	Fixed wing aircraft
Hyundai Wiya-Gyeongnam	Landing gear; pilot seats
Kyongju Aerospace Electrical Systems Gyeongju-si	Aircraft electrical system; wire harness
MDS Technology Gyeongnam	Software development solutions; infrared camera
NDT Engineering & Aerospace Gyeongnam	Precision manufacturing; advanced CAD/CAM
Samsung Thales Gyeonggi-do	Avionics; electronic warfare systems
Soosung Airframe Gyeongsangnam-do	Sheet metal; machining; assembly

Taiwan

Taiwan has not formally decided to participate in the JSF program and the United States may be reluctant to sell the JSF to Taiwan due to its desire to maintain stable relations with China. However, the increasing growth of Chinese military power in the Taiwan Straits is placing Taiwan at a competitive strategic disadvantage and may cause a future US presidential administration to consider selling the JSF to Taipei. The following excerpt from a 2012 report by the US Army's Foreign Military Studies Office describes potential military benefits but economic political problems with Taiwanese purchasing of the JSF:

> Though the F-35B fighters are especially attractive for short take-off and vertical landing (STOVL) and other innovative capabilities that are well suited for Taiwan's terrain and other needs, many believe the program is not feasible because of the high cost and Taiwan's budgetary constraints. Further, in order to host F-35Bs, the island would require a restructuring of maintenance facilities, which may prove too expensive. Limited availability means delivery would be many years coming. However, others note that by the time Taiwan actually receives the F-16C/Ds, they may be outdated and the F-35Bs more cost-effective.[48]

Taiwan's Air Force has used US-supplied F-16 A/B aircraft since they were delivered in April 1997. It has been unable to get more advanced aircraft such as the F-16 C/D since then due to US concerns over inflaming China. Taipei has been able to acquire Mirage 2000–5 aircraft from France and some Taiwanese and US interests advocate selling the JSF to Taiwan to give it more of a chance to deter a potential cross-strait invasion as a result of Taipei's declining air defense capabilities, Beijing's growing ballistic missile arsenals, and China's 2014 purchase of Russian SU-35 fighters placing all of Taiwan within scope of Beijing's air defense network.[49]

A key factor prompting potential Taiwanese interest in the JSF is the continuing and growing military advantage China has over Taiwan. Table 8.15 from the 2016 edition of the Defense Department's annual report on Chinese military power illustrates how pronounced Beijing's airpower advantage is in terms of military aircraft (Table 9.4).

China has made significant efforts to bolster its defense forces across the Taiwan Strait and has increased its capability of conducting various kinds of coercive operations against Taiwan including air and missile campaigns, amphibious invasion, and cyber and other joint force attacks to demoralize the Taiwanese and deter potential US intervention. Taiwan has historically relied on the geographic barrier posed by the 100-mile-wide Taiwan Strait, its military's technological superiority, and the advantages of defending an island. China's increasingly modern weapons platforms including over 1200 ballistic missiles, ships, submarines, combat aircraft, and improved C4ISR capabilities have eroded or negated these advantages.

Taiwan has addressed some of these deficiencies by increasing its war reserve stocks, expanding its defense industrial base, and improving its joint operations and crisis response capabilities. Taipei is also working to integrate asymmetric measures into its defense capabilities to offset Chinese advantages. However, questions remain about the effectiveness of

Table 9.4 China-Taiwan cross-strait airpower balance[50]

China			*Taiwan*
Aircraft	*Total*	*Within range of Taiwan*	*Total*
Fighters	1700	130	384
Bombers/Attack	400	200	0
Transport	475	150	19
Special mission aircraft	115	75	25

Taiwan's air power due to its age and flat defense spending which fell from 4.7% of GDP in 1994 to 1.9% of GDP in 2015 and from 16.4% to 10.6% of government spending over this time period.

US policy toward Taiwan adheres to the one-China policy, three US-China joint communiques, and the Taiwan Relations Act (TRA) with the latter statute requiring the United States to come to Taiwan's defense. The United States says it opposes destabilizing changes in the cross-straits' status quo, but has provided Taiwan with enough materials to maintain what it considers as defense self-sufficiency. The United States has announced $12 billion in arms sales to Taiwan since 2010 including an F-16A/B retrofit, training, and spare parts for Taiwan's Air Force. However, the Obama Administration did not provide the F-16 C/D or consider providing Taipei with the JSF.[51]

In August 2014, Taiwanese Major General Chang Wen-shuo, the Deputy Director General for the Defense Ministry's Department of Strategic Planning, said Taiwan wanted to purchase the F-22 and JSF. He stressed that weapons such as these would help meet Taiwan's requirements for innovation and asymmetric warfare in the event of a conflict with China. He went on to stress that Taiwan faces a rising air threat from China as it increases the PLAAF by building advanced J-20 and J-31 fighters, purchasing Russian Su-35 fighters, and S-400 air defense missiles.[52]

Taiwan's ability to acquire the JSF and other cutting-edge military technology has been limited by the fear of the United States and other Western powers of jeopardizing their important economic and strategic relationships with an increasingly assertive China if they were to sell Taiwan advanced weaponry which would bolster Taipei's competitiveness in the Taiwan Strait region. Taiwan has also hurt its cause by providing insufficient overall support to its own military capabilities as evidenced by declining defense spending, increasing economic integration with China, a misguided belief that economic interdependence with China decreases the possibility of military conflict and political feuding between Taiwan's two main political parties—the pro-independence Democratic Progressive Party (DPP) and the one-China orientation of the Kuomintang (KMT)—over appropriate defense policy.[53]

Taiwan's 2015 Defense White Paper stressed its efforts to improve joint operational efforts and information and electronic warfare capabilities, noted Chinese assertiveness in the East and South China Seas while also maintaining Beijing practiced "amicable diplomacy" with its neighbors, and sought to deny external intervention in the cross-straits dispute.

Taipei is responding by reducing its military personnel and striving to increase the professional quality of its forces, hardening its information security assets, and acquiring modernized weapons, and having its Air Force strive for regional air superiority.[54]

The 2016 election of Taiwan's Democratic Progressive Party lead by President Tsai Ing-wen may result in Taiwan taking steps to increase its defense spending which could receive a favorable response from the Trump Administration in the form of increased US arms sales. On January 24, 2017, Taiwanese Defense Minister Feng Shih-kuan announced that next-generation fighter jets would become a Tsai Administration research and development priority. A February 11, 2017, article in the congressional newspaper *The Hill* by Taiwanese authors noted the growing disparity in the cross-strait military aircraft balance between Taiwan and China, urging the United States to sell the JSF to China in order to lessen Beijing's increasing numerical and technological aircraft superiority over Taiwan.[55]

During May 2017, Taiwan's Defense Minister Feng Shih-kuan announced that Taipei would formally declare its intention to purchase the JSF when he visited Washington in July citing China's military developments as justification for this purchase. However, it is uncertain whether the Trump Administration will favor this given its efforts to acquire Chinese help in dealing with North Korea and the contention of some sources that the United States wants its next round of Taiwanese arms sales to emphasize anti-ship, surface-to-air, and surface-to-surface missile systems. An analysis of this potential scale maintained that purchasing the JSF would be financially expensive for Taipei and that the JSF would be vulnerable to attacks from Chinese ballistic missiles and jet fighters.[56]

Taiwan JSF Industrial Participation

If the Trump Administration decides to allow Taiwan to purchase or participate in the JSF, Taiwan has some indigenous domestic aerospace industrial capacity to take advantage of this program's opportunities. Taipei has co-produced domestic versions of the F-5E fighter since the 1970s and from 1988 to 1999 produced the Indigenous Defense Fighter (IDF) and is currently producing an updated line of the IDF as part of Project Hsiang-Chan.[57]

In 1969, the Aerospace Industrial Development Corporation (AIDC) was created and it was transferred from a military-owned enterprise to a state-owned company based in Taichung under the Ministry of Economic

Table 9.5 Potential Taiwanese JSF contractors[60]

Acer Sertek Inc Taipei	Avionics
Aerowin Technology Corporation Tainan City	Aluminum metal technology; precision machining
Chen-Tech Taiwan Industries Taoyuan County	Forged engine and aircraft components; forged defense products
Eagle Engineering Aerospace Taipei	Aircraft and satellite parts and repairs
National Aerospace Fasteners Corp. Tao-Yuan Hsien	Aerospace fitting and fasteners
Opto Tech Corporation Hsinchu	LED chips and display
Taiwan Aerospace Corporation Taipei	Aircraft structural parts; engine components
Zitai Precision Machinery Taichung	Aerospace parts

Affairs in 1996 with production capabilities in aeronautic engines, and aircraft avionics before being privatized in 2013–2014.[58] Taiwanese exports of transportation equipment, including aircraft, were $108 million in 2016 declining from $117 million in 2014, $109 million through November 2017, the size of its transportation and storage workforce was 437,000 as 2015, and its 2014 aerospace industry earnings were estimated to be $2.67 million.[59]

The Taiwan Aerospace Industry Association (TAIA) has 63 member companies with potential beneficiaries of working on the JSF besides AIDC including those listed in Table 9.5.

Turkey

NATO member Turkey became interested in developing a replacement to the F-16 and in the mid-1990s joined other countries in seeking to become part of the JSF consortium. Negotiations began with Washington in 1999 with tacit approval being granted for Ankara's program participation March 2000. In a March 31, 2000, speech to the American Turkish Council Secretary of Defense William Cohen commented: "Turkey is that vital link in terms of blending Russia and Central Asia and the Caucasus and bridging the gap between the Western world and the Islamic world. No other country sits in this position to be able to achieve that great result."[61]

Turkey agreed to sign a system development and demonstration MOU with the United States concerning the JSF on January 17, 2001, which was officially signed on July 11, 2002, and entered into force on August 10, 2002. Turkish participants in this included Ankara's Undersecretary for Defense Industries and Turkish Air Force members or civilians who were assigned to the JSF program office. Turkey's contributing share was $175 million in current year's dollars with possible additional contributions not to exceed $75 million.[62]

Despite this MOU, there were uncertainties about Turkey's participation level, local workshare, and access to software source codes which may have contributed to Ankara's Level 3 partner status as of July 2002. A March 1, 2003, Turkish Parliament vote prohibiting US troops from deploying to Turkey for Operation Iraqi Freedom and the July 4, 2003, apprehension of Turkish special forces by US troops in Sulaymaniyah, Iraq, further weakened US-Turkish military relations and enthusiasm for participating in JSF. The year 2005 saw the Eurofighter become increasingly appealing to Ankara and in January 2006 Lockheed Martin offered local workshare worth $3.5 billion which Turkey found insufficiently satisfactory.[63]

In October 2006, Turkish Defense Minister Vecdi Gönül and Turkish JSF program head Murad Bayer visited Washington and made sufficient progress in a meeting with Secretary of Defense Donald Rumsfeld that Turkey signed a new agreement in November 2006 indicating that the JSF was their preferred jet fighter without committing to buying the aircraft, consequently eliminating the Eurofighter as an alternative option. The MOU signed in January 2006 secured an increase in Turkish JSF workshare value from $4.2 to $5 billion and the Turkish aerospace industry was given the right to manufacture the fuselage for nearly 400 F-35s.[64]

During 2011, Turkey's JSF program workshare was determined to be unsatisfactory by government procurement officials. Program cost overruns took Turkish workshare below a 50% targeted level. At this time, unfulfilled Turkish JSF expectations including the desire to host a regional FACO facility for F-35 engines were seriously damaged by the US decision to cancel the GE F-136 engine and unsuccessful efforts to contain JSF source codes. On January 5, 2012, Turkey finally placed its first order for only two instead of six F-35As. In January 2013, Turkey suspended its orders for these aircraft contending it had not shown the projected operational capability level and acknowledging other consortium partners had postponed their orders. Possible reconsideration of the F-35 order was expected in 2014.

However, Turkey expects to be able to operate the JSF without restrictions which remains problematic for reasons as varied as Ankara's policy disagreements with Washington on issues such as Israel and Palestine, the Erdogan Government's more Islamist domestic policies, and its insistence on significant work-sharing and source code access.[65] Even with these problems, Prime Minister Ahmet Davutoglu announced on January 7, 2015, that Turkey planned to order an additional four F-35s following up on its 2012 order of two F-35s.[66]

Concern over the Turkish government's stability following an unsuccessful July 15, 2016, coup attempt and the authoritarian rule of President Recep Tayyip Erdogan has slowed, but not delayed, Turkish participation in the JSF. On July 20, 2016, Lockheed Martin spokesman Mike Rein confirmed Ankara would receive JSF fighters as part of the low-rate initial production and that their assembly would begin in the next 6–12 months. On October 31, 2016, Ankara's Defense Industry Executive Committee consisting of Prime Minister Binali Yildirim, Defense Minister Fikri Isik, and Chief of Staff General Hulusi Akar agreed to order a second round of JSFs, expanding Turkey's commitment to purchasing a total of 116 JSF. Turkey hopes to receive its first JSF in 2018 and to build a new generation fighter fleet consisting of the JSF and an indigenously constructed TFX aircraft to commemorate the country's centennial in 2023.[67]

Turkish defense contractor Roketsan has developed a stand-off missile to fit into the JSF's weapons bay. This air-to-surface missile has a range of approximately 135 miles, weighs approximately 1333 pounds, and features multiple guidance systems including GPS, imaging infrared seeker, and automatic target acquisition along with a semi-armor piercing warhead capable of targeting ships, SAM sites, strategic assets, and exposed Warcraft. This missile will be incorporated into Turkish JSFs and may be integrated into US JSFs.

Despite these Turkish technological accomplishments, concern remains over the authoritarian tendencies of the Erdogan government and whether Turkey can be trusted with JSF secrets and technologies. One July 2017 analysis warned that in 2013 Turkey leaked the identities of Israeli spies in Iran to that country's government. Another incident that month saw the Pentagon criticize Turkey's state-run news agency for exposing ten covert US bases in Syria to enable Daesh and Iranian-backed forces to target Americans. These concerns have been further exacerbated by Ankara's increasing ties and cooperation with China and Russia which could give information on the JSF and its technology to hostile actors. An acute expression of US congressional concern with Turkey and the F-35 was expressed in the 2019 National Defense Authorization Act signed by President Trump on August 13, 2018. Section 1271 of this legislation expressed concern over Turkey's purchase of an S-400 air and missile defense system from Russia and required the Defense and State Departments to submit a report to Congress within 60 days on the status of the US relationship with Turkey including US military activities at Incirlik Air Base and the impact this purchase could have on joint US and Turkish operated and produced weapons systems including the JSF.[68]

Turkish JSF Industrial Participation

Turkish Aviation Industries (TAI) has been interested in developing an indigenous F-X fighter as a result of complications with the JSF and Turkey is also developing a stand-off missile similar to the US Joint Direct Attack Munition (JDAM) having received permission to acquire JDAM from the United States. Turkish contractors with JSF include both government entities like TAI and Tubitak-SAGE and private sector organizations. The value of these contracts is expected to reach $12 billion and contractors are listed in Table 9.6 and primarily concentrated near Ankara and Istanbul.

Table 9.6 Turkish JSF contractor[69]

Alp Aviation Ankara and Eskisehir	F-35 airframe production structure and assemblies, production landing gear components, and production F-135 engine titanium blade rotors.
Aselsan Ankara	Manufacturing approaches for advance optical components which are part of F-35 electrical targeting system and Communications, Navigation, and Identification (CNI) avionic interface controller.
Ayesas Ankara	Sole source supplier for missile remote interface unit and panoramic cockpit display.
Fokker-Elmo Izmir	Manufactures 40% of electrical wiring and interface system and supporting TAI with all center section wiring systems.
Havelsan Ankara and Istanbul	Training systems and future integrated pilot and Maintenance Training Center.
Kale Aerospace Istanbul	Airframe structures and assembly, sole source supplier for landing gear lock assemblies for all three JSF variants, joint venture with Pratt & Whitney in Izmir to manufacture engine production hardware.
MiKES Istanbul	Delivers F-35 aircraft components and assemblies for BAE Systems and Northrup Grumman.
Roketsan and Tubitak-Sage Ankara	Development, integration, and production of advanced precision-guided stand-off missile carried internally on F-35.
Turkish Aerospace Industries Ankara	Production hardware including center fuselages, composite skins, weapon bay doors, and fiber placement composite air inlet ducts.

Conclusion

Decisions to participate or not participate in the JSF in each of these countries have varied. Some countries have made the decision to purchase the JSF and participate in this program with relatively limited controversy, while others have faced considerable controversy, delays, and opposition to participating in the JSF program. Factors influencing the decision-making of these countries include economic costs, program delays and cost overruns, the desire to ensure indigenous aerospace industries get contractual opportunities to participate in JSF, the need to maintain interoperability with US and other NATO forces, and the need to address emerging aerospace threats from adjacent hostile powers as varied as China, Iran, North Korea, Russia, and transnational terrorist organizations. An additional factor complicating security policy decision-making and weapons purchasing in these countries has been declining defense spending and perceived public reluctance to support military upgrades to aging fighter forces in the emerging international security environment and challenging questions as to whether the JSF is the best mechanism for addressing national military airpower needs during a period when the development of UAV technologies is causing some to question whether manned combat aircraft remain necessary. The reliability of JSF partner countries such as Turkey also poses legitimate security concerns about whether the widespread global dissemination of JSF technology may have adverse geopolitical effects on the US and allied countries participating in this program.[70]

Notes

1. Giles Scott-Smith and Max Smeets, "Noblesse Oblige: The Transatlantic Security Dynamic and Dutch Involvement in the Joint Strike Fighter Program," *International Journal*, 68 (1) (Winter 2012–13): 49–51; https://doi.org/10.1177/0020702013068 00105; and Zachary Cohen, "U.S. F-35 Fighter Jets Arrive in Japan Ahead of Trump Visit," *CNN Politics* (October 31, 2017): 1–4; http://www.cnn.com/2017/10/31/politics/us-f-35-fighter-jets-arrive-japan/index.html; accessed January 4, 2018.
2. Ibid., 53.
3. Ibid., 51–66.
4. Douglas Barrie, "Dutch JSF Deal a Blow to European Fighters," *Aviation Week and Space Technology*, 156 (7) (February 18, 2002): 26–27.

5. Michael Mecham, "Industry Outlook," *Aviation Week and Space Technology*, 159 (14) (October 6, 2003): 27.
6. "The F-35 Joint Strike Fighter," *Aviation Week and Space Technology*, 165 (11) (September 18, 2006): 57.
7. See "The Dutch Government Says," *Aviation Week and Space Technology*, 165 (14) (October 9, 2006): 77; and Barrie, "Lightning Strike," *Aviation Week and Space Technology*, 165 (20) (November 20, 2006): 99.
8. Matt Bassford, Maarten van den Voort, et al., *The Netherlands F-16 Comparative Analysis: An Evaluation of the Process* (Santa Monica: Rand Corporation 2008): 17–18, 22, 24–25, 35, 44; http://www.rand.org/content/dam/rand/pubs/technical_reports/2008/RAND_TR656.pdf; accessed April 18, 2017.
9. Netherlands, Court of Audit, *Joint Strike Fighter Exit Costs* (The Hague: Court of Audit, 2012): 17–18, 20–22; https://english.rekenkamer.nl/binaries/rekenkamer-english/documents/reports/2012/10/24/cost-of-withdrawing-from-the-joint-strike-force-programme/Report+JSF+met+cover.pdf; accessed January 4, 2018.
10. Ibid., 23–32.
11. Ibid., *Validation of the Policy Document 'In the Interests of the Netherlands'* (The Hague: Court of Audit, 2013): 26, 30; https://english.rekenkamer.nl/binaries/rekenkamer-english/documents/reports/2013/09/19/validation-of-the-policy-document-in-the-interests-of-the-netherlands/Report+Validation+of+the+policy+document+In+the+Interests+of+the+Netherlands.pdf; accessed March 13, 2017.
12. Tony Osborne and Amy Butler, "Difficult Choices," *Aviation Week and Space Technology*, 175 (33) (September 23, 2013): 34.
13. Anno Gravemaker, "Dutch Parliament Approves First F-35 Production Order," *Flightglobal* (March 3, 2015): 1; http://www.flightglobal.com/news/articles/dutch-parliament-approves-first-f-35-production-order-409673/; accessed April 17, 2017.
14. See Netherlands, House of Representatives, "F-35/JSF" (The Hague: House of Representatives, 2016): 1–2; https://www.houseofrepresentatives.nl/dossiers/f-35jsf; accessed April 18, 2017; Netherlands Aerospace Centre, "Hardened Aircraft Shelters in the Netherlands Suitable for F-35 Aircraft" (Amsterdam: Netherlands Aerospace Centre, 2016): 1–2; http://www.nlr.org/news/hardened-aircraft-shelters-on-air-force-bases-in-the-netherlands-suitable-for-f-35-aircraft/; accessed April 23, 2017; and "European Leaders Breathe Easier as Rutte Routs Wilders," *Deutsche Welle* (March 16, 2017): 1–4; http://www.dw.com/en/european-leaders-breathe-easier-as-rutte-routs-wilders/a-37957091; accessed April 23, 2017.

15. Janene Pieters, "Dutch Gov't Maybe Can't Afford Last Three JSF Fighter Jets," *NL Times* (November 30, 2017): 1; https://nltimes.nl/2017/11/30/dutch-govt-maybe-cant-afford-last-three-jsf-fighter-jets; accessed January 4, 2018.
16. See Netherlands, Ministry of Defence, "Director of F-35 Programme: Price of F-35 to Fall" (The Hague: Ministry of Defence (January 15, 2015): 1–2; http://www.defensie.nl/english/latest/news/2015/01/15/director-of-f-35-programme-%E2%80%98price-of-f-35-to-fall%E2%80%99; accessed April 18, 2017; and U.S. Department of Defense, Office of the Deputy Undersecretary of Industrial Policy, *JSF International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers* (Washington, DC: DOD, 2003): D-1 to D-15; http://permanent.access.gpo.gov/lps61713/Acr9B.tmp.pdf; accessed April 18, 2017.
17. Ringsmose, 99.
18. Ibid.
19. See Ibid., 100–101; Joris Janssen Lok, "Growing the Gripen," *Aviation Week and Space Technology*, 68 (26) (June 30, 2008): 42–43; "Norway Rejects Gripen, Stays With F35 JSF," *Aviation Week and Space Technology*, 169 (20) (November 24, 2008): 16; and Norway, *HM The King's Report to the Storting on the State of the Realm and the Administration of the Government During the Period Since the Previous Report* (Oslo: Norwegian Government, October 15, 2009): 15; https://www.regjeringen.no/en/aktuelt/hm-the-kings-report-to-the-storting-on-t/id579235/; accessed April 20, 2017.
20. "Competitive Pressure," *Aviation Week and Space Technology*, 174 (8) (February 27, 2012): 29.
21. Robert Wall, "Joining Up," *Aviation Week and Space Technology*, 174 (12) (April 2, 2012): 40.
22. Norway, Ministry of Defence, *Norway Releases New Defence Plan; Emphasises Improved Operational Capability, Personnel and Updated F-35 Procurement Schedule* (Oslo: Ministry of Defence, March 23, 2012): 3–4; https://www.regjeringen.no/en/aktuelt/norway-releases-new-defence-white-paper-/id676237/; accessed April 20, 2017.
23. Norway, Ministry of Defence, The F-35 Combat Aircraft: Important to "Keep up the Good Progress" (Oslo: Ministry of Defence, January 20, 2014): 1–3; https://www.regjeringen.no/en/aktuelt/the-f-35-combat-aircraft-important-to-ke/id748968/; accessed April 20, 2017.
24. See Ibid., *Government Proposes 3.4% Defence Budget Increase in 2015* (Oslo: Ministry of Defence, October 13, 2014): 1–4; https://www.regjeringen.no/en/aktuelt/Proposing-34-Defence-Budget-Increase-in-2015/id2005697/; accessed April 20, 2017; and Ibid., *Future Acquisitions for the Norwegian Armed Forces 2015–2023* (Oslo: Ministry of Defence,

2015): 6–7; https://www.regjeringen.no/globalassets/departementene/fd/dokumenter/rapporter-og-regelverk/acquisitions-2015-2023.pdf; accessed April 20, 2017.

25. Lockheed Martin, "Weight on Wheels" for Norwegian Armed Forces' First F-35" (Fort Worth: Lockheed Martin, April 16, 2015): 3; https://www.f35.com/news/detail/weight-on-wheels-for-norwegian-armed-forces-first-f-35; accessed April 20, 2017.
26. See Sigurd Neubauer, *Norway, the Joint Strike Fighter Program and Its Implications for Transatlantic Defense Cooperation* (Oslo: Norwegian Institute of International Affairs, 2015): 1–2; https://www.files.ethz.ch/isn/195614/NUPI_Policy_Brief_27_15_Sigurd_Neubauer.pdf; accessed April 20, 2017; and Kyle Mizokami, "F-35 Friendly Norwegian Strike Missile Tested Over Utah," *Popular Mechanics* (December 22, 2016): 1–2; http://www.popularmechanics.com/military/weapons/a24459/norwegian-strike-missile-tested-over-utah/; accessed April 20, 2017.
27. See Norway, Ministry of Defence, "Army Summit 2016 - Defence Minister Ine Eriksen Søreide's Opening Remarks" (Oslo: Ministry of Defence, September 20, 2016): 3, 5; https://www.regjeringen.no/en/aktuelt/army-summit-2016%2D%2D-defence-minister-ine-eriksen-soreides-opening-remarks/id2511838/; accessed April 20, 2017; and Ibid., *Capable and Sustainable: Long-Term Defence Plan* (Oslo: Ministry of Defence, June 20, 2016): 7; https://www.regjeringen.no/globalassets/departementene/fd/dokumenter/rapporter-og-regelverk/capable-and-sustainable-ltp-english-brochure%2D%2D-print.pdf; accessed April 20, 2017.
28. Norway, Prime Minister Erna Solberg, "The Arrival in Norway of the First F-35 Lightning II Jets" (Oslo: Office of the Prime Minister, November 10, 2017): 1–3; https://www.regjeringen.no/en/aktuelt/the-arrival-in-norway-of-the-first-f-35-lightning-ii-jets/id2578604/; accessed January 4, 2018.
29. See Promising the Sky, 14, 18; Lockheed-Martin, "Norway F-35 Partnership" (2015): 1–2; https://www.f35.com/global/participation/norway; accessed April 20, 2017; Ibid., "First F-35 for Norway Progressing Towards Delivery" (February 6, 2015): 1–2; https://www.f35.com/news/detail/first-f-35a-for-norway-progressing-towards-delivery; accessed April 20, 2017; and Ibid., "Lockheed Martin F-35A Icy Runway Testing for Norwegian Drag Chute Underway in Alaska" (November 27, 2017): 5–7; https://www.f35.com/news/detail/lockheed-martin-f-35a-icy-runway-testing-for-norwegian-drag-chute-underway; accessed January 4, 2018.
30. See Kelvin Wong, *F-35 Joint Strike Fighter: Singapore's Next-Generation Fighter?* (Singapore: S. Rajaratnam School of International Studies, 2013): 1–2; http://www.rsis.edu.sg/wp-content/uploads/2014/07/CO13048.

pdf; accessed April 21, 2017; and Singapore, Ministry of Defence, "Speech by Minister for Defence Dr. Ng Eng Hen at the Committee of Supply Date 2013" (Singapore: Ministry of Defence, 2013): 2.

31. Ibid., Koh Eng Beng, "Integrated Strike Exercise Adds Thinking Enemy" (Singapore: Ministry of Defence, 2013): 1–2; https://www.mindef.gov.sg/imindef/resourcelibrary/cyberpioneer/topics/articles/news/2013/dec/11dec13_news.html#.WMgYgIWcF9A; accessed April 21, 2017.
32. Singapore Ministry of Finance, *Budget: Revenue and Expenditure Estimates* (Singapore: Ministry of Finance, 2017): 63–66; https://www.singaporebudget.gov.sg/data/budget_2017/download/25%20MINDEF%202017.pdf; accessed June 11, 2018.
33. *The Global Arms Industry in 2030* (And Beyond) (Singapore: S. Rajaratnam School of International Studies, 2014): 22; http://www.rsis.edu.sg/wp-content/uploads/2015/01/ER150123_Global_Arms_Industry.pdf; accessed April 21, 2017.
34. Nigel Pittaway, "U.S. Program Chief: Singapore Nearing F-35 Buy," *Defense News* (February 25, 2015): 1–2; http://www.defensenews.com/story/defense/show-daily/avalon/2015/02/24/avalon-australia-f35-fms-bogdan-deeble-singapore/23927983/; accessed April 21, 2017.
35. Sreekanth Shankar, James Phang, Ng Guo Feng, and Tan Peng Yu, "Sustaining a Strong and Capable RSAF for the Future," *Pointer 2016 Supplement*, 16; https://www.mindef.gov.sg/content/dam/imindef_media_library/graphics/pointer/PDF/2016/af-supp2016/af-supp2016_full.pdf; accessed April 21, 2017.
36. See Aaron Mehta, "Singapore Eyes F-35 for 2030 Time Frame," *Defense News* (October 3, 2016): 1; https://www.defensenews.com/air/2016/10/03/singapore-eyes-f-35-for-2030-time-frame/; accessed June 11, 2018; and Singapore Budget, *Summary Table of Revenues and Expenditure Estimates: Total Estimates Outlays for FY 2017 By Head of Expenditure* (Singapore: Singapore Budget 2017): 5; https://www.singaporebudget.gov.sg/data/budget_2017/download/05%20Government%20Expenditure%202017.pdf; accessed June 11, 2018.
37. See Singapore, Economic Development Board, *Aerospace Engineering Singapore* (Singapore: Economic Development Board, 2017): 1–2; https://www.edb.gov.sg/content/edb/en/industries/industries/aerospace-engineering.html; accessed April 21, 2017; and Ibid., *Aerospace: Singapore-Asia's Aerospace Hub* (Singapore: Economic Development Board, 2017): 2–4; https://www.edb.gov.sg/content/dam/edb/en/resources/factsheetsnew/Aerospace-Engineering.pdf; accessed April 21, 2017.
38. See Bradley Perrett, "High Anxiety," *Aviation Week and Space Technology*, 173 (20) (June 6, 2011): 20; and David Hay, *Japan's Strategic Re-Posture:*

Prime Minister Abe and the Implications for the Japan-US Alliance and Regional Security (Canberra: Australian Defence College, Centre for Defence and Strategic Studies, 2014): 12; http://www.defence.gov.au/ADC/Publications/IndoPac/Hay%20final%20paper%20(2).pdf; accessed May 24, 2017.

39. See Ibid.; and South Korea, Ministry of National Defense, *2012 Defense White Paper* (Seoul: Ministry of National Defense, 2012); http://www.mnd.go.kr/cop/pblictn/selectPublicationUser.do?siteId=mndEN&componentId=51&categoryId=0&publicationSeq=585&pageIndex=1&id=mndEN_031300000000; accessed May 24, 2017.
40. Perrett, "Another KF-X Enemy," *Aviation Week and Space Technology*, 175 (6) (February 18, 2013): 23.
41. See U.S. Defense Security Cooperation Agency, "Korea-F-35 Joint Strike Fighter Aircraft" (Washington, DC: DSCA, April 3, 2013): 1–2; http://www.dsca.mil/sites/default/files/mas/korea_13-10_0.pdf; accessed May 24, 2017.
42. See Perrett and Amy Butler, "Seoul Survivor," *Aviation Week and Space Technology*, 175 (34) (September 30, 2013): 28; and Sebastian Sobolev, "F-35 Back in the Fight for South Korea's FX-III Competition," *Avascent Analytics Blog* (September 24, 2013): 1–2; http://www.avascent.com/2013/09/f-35-back-in-the-fight/; accessed May 24, 2017.
43. See Joyce Lee, "South Korea Boosts Air Defenses With About $6.8 Billion Budget for F-35s," *Reuters* (March 24, 2014): 1–3; http://www.reuters.com/article/us-korea-jets-idUSBREA2N07220140324; accessed May 24, 2017; Zachary Keck, "South Korea to Purchase F-35s," *The Diplomat* (March 25, 2014): 1; http://thediplomat.com/2014/03/south-korea-to-purchase-f-35s/; accessed May 24, 2017; Keck, "America's Air-Sea Battle Plan in Korea," *The Diplomat* (June 20, 2014): 1–2; http://thediplomat.com/2014/06/americas-air-sea-battle-plan-in-korea/; accessed May 24, 2017; and South Korea, Ministry of National Defense, *2014 Defense White Paper* (Seoul: Ministry of National Defense, 2014): 49–55; http://www.mnd.go.kr/cop/pblictn/selectPublicationUser.do?siteId=mndEN&componentId=51&categoryId=0&publicationSeq=689&pageIndex=1&id=mndEN_031300000000; accessed May 24, 2017.
44. Cho Nam Hoon, "Status of the 2017 ROK Defense Budget and Its Implications," *ROK Angle: Korea's Defense Policy #147*, www.kida.re.kr/cmm/viewBoardImageFile.do?idx=21723; accessed May 24, 2017.
45. See Jeff Daniels, "South Korea, Japan May Put the F-35B Stealth Fighter on Combat-Capable Ships," *CNBC* (December 28, 2017): 1–4; https://www.cnbc.com/2017/12/28/south-korea-japan-may-put-f-35b-stealth-jets-on-combat-capable-ships.html; accessed January 4, 2018; and Taehon Lee, James Griffith, and Joshua Berlinger, "U.S. Fighter Jets Stage Mock

Bombing Drill Over Korean Peninsula," *CNN Politics* (August 31, 2017): 1–5; http://www.cnn.com/2017/08/31/politics/us-bombers-korean-peninsula/index.html; accessed January 4, 2018.

46. U.S. Department of Commerce, International Trade Administration, "Leading Sectors for U.S. Export Investment: Aerospace Industry" (Washington, DC: International Trade Administration, 2016): 1–3; https://www.export.gov/article?id=Korea-Aerospace-Industry; accessed May 24, 2017; and Korea Aerospace Industries Association, *Korea Aerospace Industry 2015* (Seoul: Korea Aerospace Industries Association, 2015): 4–7; http://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/28150507103312/28150507103312_3.pdf; accessed May 24, 2017.
47. Korea Aerospace Industry 2015, 32–51.
48. Lianna Nicole Faruolo, *An Update on the Taiwan Defense Situation (2011–2012)* (Fort Leavenworth, KS: Foreign Military Studies Office, 2012): 7.
49. See Taiwan, Air Force Command Headquarters, "History" (Taipei: Air Force Command Headquarters, February 24, 2017): 1; http://air.mnd.gov.tw/english/Webpage.aspx?entry=354; accessed June 5, 2017; Kent Wang, "Why The U.S. Should Sell Advanced Fighters to Taiwan," *The Diplomat* (January 10, 2014): 1; http://thediplomat.com/2014/01/why-the-us-should-sell-advanced-fighters-to-taiwan/; accessed June 5, 2017; and Shannon Tiezzi, "Why the U.S. Will Not Sell Advanced Fighters to Taiwan," *The Diplomat* (January 11, 2014): 1; http://thediplomat.com/2014/01/why-the-us-will-not-sell-advanced-fighters-to-taiwan/; accessed June 5, 2017.
50. U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China* (Washington, DC: DOD, 2016): 109; https://www.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf; accessed June 5, 2017.
51. Ibid., 87–91; Public Law 96–8, "Taiwan Relations Act," 93 U.*S. Statutes at Large*, 14–21; https://www.gpo.gov/fdsys/pkg/STATUTE-93/pdf/STATUTE-93-Pg14.pdf; accessed January 4, 2018; Dennis V. Hickey, "Dilemmas for US Strategy: Imbalance in the Taiwan Strait," *Parameters*, 43 (3) (Autumn 2013): 43–53; Dean Cheng, "Getting Serious About Taiwan's Air Power Needs" (Washington, DC: The Heritage Foundation, 2011): http://www.heritage.org/research/reports/2011/10/getting-serious-about-taiwans-air-power-needs; accessed June 5, 2017; and Stockholm International Peace Research Institute (SIPRI), *Military Expenditure Database* (Stockholm: SIPRI, 2017): https://www.sipri.org/sites/default/files/SIPRI-Milex-data-1988-2015.xlsx; accessed June 5, 2017.

52. "Taiwan Still Hopes to Buy F-35 Fighters from U.S.: Defense Official," *Pacific Sentinel* (August 21, 2014): 1–2; http://pacificsentinel.blogspot.de/2014/08/news-story-taiwan-still-hopes-to-buy-f.html; accessed March 24, 2017.
53. Andrew T.H. Tan, "The Implications of Taiwan's Declining Defense," *Asia-Pacific Review*, 21 (1) (2014): 41–62; https://doi.org/10.1080/13 4390006.2014.921125.
54. Taiwan, Ministry of National Defense, *National Defense Report 2015* (Taipei: Ministry of National Defense, 2015): 25, 41–42, 52, 68, 78, 121; https://china.usc.edu/sites/default/files/article/attachments/taiwan-2015-national-defense-report.pdf; accessed June 11, 2018.
55. See Elizabeth Shim, "Taiwan Developing Next-Generation Fighter Jets, Defense Minister Says," *UPI* (January 24, 2017): 2–4; http://www.upi.com/Top_News/World-News/2017/01/24/Taiwan-developing-next-generation-fighter-jets-defense-minister-says/9431485284790/; accessed June 5, 2017; and Yen Wong and Kent Wang, "Sell Advanced Fighters to Taiwan," *The Hill* (February 11, 2017): 1–2; http://thehill.com/blogs/congress-blog/foreign-policy/318994-sell-advanced-fighters-to-taiwan; accessed June 5, 2017.
56. Franz-Stefan Gady, "Taiwan Pushes for Sale of F-35 Fighter Jets," The Diplomat (May 3, 2017): 1–2; https://thediplomat.com/2017/05/taiwan-pushes-for-sale-of-f-35-fighter-jets/; accessed January 4, 2018.
57. Pei-Leen Liu, "The Development of a Military Aircraft Industry for Latecomers: The Case of Taiwan," *The Korean Journal of Defense Analysis*, 26 (1) (March 2014): 97–116.
58. Tim Ferry, "Taiwan's Aviation Industry: Readying for Takeoff" (Taipei: American Chamber of Commerce in Taipei, December 16, 2015): 1–5; http://topics.amcham.com.tw/2015/12/taiwans-aviation-industry-readying-for-takeoff/; accessed June 5, 2017.
59. Taiwan, Ministry of Economic Affairs, Department of Statistics, *Economic Indicators: B-6 Export by Commodity* (Taipei: Ministry of Economic Affairs, 2018): 9; https://www.moea.gov.tw/Mns/main/content/wHandMenuFile.ashx?file_id=18159; accessed June 11, 2018; and *Statistical Yearbook of the Republic of China 2015* (Taipei: Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, Republic of China, 2016): 16; http://ebook.dgbas.gov.tw/public/Data/610281138403HCL2D3O.pdf; accessed June 5, 2017; and Ferry, 2.
60. Taiwan Aerospace Industry Association, Member Product (Taipei: Taiwan Aerospace Industry Association, 2015): 1–6; http://www.taia.org.tw/en/product.asp; accessed June 5, 2017.
61. See Serhat Güvenç and Lerna K. Yanik, "Turkey's Involvement in the F-35 Program: One Step Forward, Two Steps Backward?," *International*

Journal, 68 (1) (Winter 2012–13): 119–120; https://doi.org/10.1177/002070201306800108; and U.S. Department of Defense, "American Turkish Council: Remarks as Delivered by Secretary of Defense, William S. Cohen, Grand Hyatt Hotel, Washington, DC, March 31, 2000" (Washington, DC: DOD, 2000): 1–2; http://archive.defense.gov/Speeches/Speech.aspx?SpeechID=549; accessed June 6, 2017.

62. U.S. Department of State, *Treaties and Other International Acts Series 02-810, Defense Joint Strike Fighter Program: Agreement Between the United States of America and Turkey Supplementing the Memorandum of Understanding of January 17, 2001* (Washington, DC: Department of State, 2013): 5–7, 10; http://purl.fdlp.gov/GPO/gpo39157; accessed June 6, 2017.
63. Güvenç and Yanik, 120–123.
64. Ibid., 123–124.
65. See Robert Wall, "SOM Strides," *Aviation Week and Space Technology*, 173 (33) (September 19, 2011): 43; Tony Osborne, "Anatolian Ambitions," *Aviation Week and Space Technology*, 175 (19) (June 10, 2013): 48; U.S. Department of State, *Country Reports on Human Rights Practices: Turkey* (Washington, DC: U.S. Department of State, 2016): https://www.state.gov/documents/organization/265694.pdf; accessed June 6, 2017; U.S. Congress, House Committee on Foreign Affairs, Subcommittee on Europe, Eurasia, and Emerging Threats, *The Future of Turkish Democracy* (Washington, DC: GPO, 2014); http://purl.fdlp.gov/GPO/gpo52563; accessed June 6, 2017; Arthur I. Cyr, "Turkey's Continuing Role as a Pivotal Ally in a Rapidly Changing Region," *Orbis*, 59 (2) (2015): 215–232; https://doi.org/10.1016/j.orbis.2015.02.001; and Güvenç and Yanik, 127–129.
66. Lockheed Martin, "Turkey to Order Four More F-35 Fighter Jets" (Fort Worth: Lockheed-Martin, January 7, 2015): 1; https://www.f35.com/news/detail/turkey-to-order-four-more-f-35-fighter-jets; accessed June 6, 2017.
67. "Despite Tensions With U.S. Lockheed Prepares to Hand Over F-35s to Turkey," *Sputnik News* (July 20, 2016): 1–3; https://sputniknews.com/military/201607201043363472-turkey-coup-f-35s/; accessed June 6, 2017; Lara Sigelman and James Drew, "Tumult in Turkey Puts F-35 at Risk," *Aviation Week and Space Technology*, 178 (15) (July 25, 2016): 1; and Burak Ege Bekdil, "Turkey to Order New F-35 Lightning II Jets," *Defense News* (October 31, 2016): 1–2; http://www.defensenews.com/articles/turkey-to-place-new-f-35-order; accessed June 6, 2017.
68. See Vivienne Machi, "Turkish Missile Could be Integrated on F-35," *National Defense* (December 15, 2017): 1–3; http://www.nationaldefensemagazine.org/articles/2017/12/15/turkish-missile-could-be-inte-

grated-on-f35; accessed January 4, 2018; Michael Rubin, "Can Turkey Be Trusted with F-35s?," *Commentary* (July 20, 2017): 1–2; https://www.commentarymagazine.com/foreign-policy/middle-east/turkey/can-turkey-be-trusted-with-f-35s/; accessed January 4, 2018; and *H.R. 5515: National Defense Authorization Act For Fiscal Year 2019*, https://www.govinfo.gov/content/pkg/BILLS-115hr5515eh/pdf/BILLS-115hr5515eh.pdf; 987–990; accessed August 14, 2018.

69. See U.S. Defense Security Cooperation Agency, "News Release: Turkey—Joint Direct Attack Munitions (Corrected)" (Washington, DC: DSCA, December 7, 2015): 1–2; http://www.dsca.mil/sites/default/files/mas/turkey_14-01_corrected.pdf; accessed June 6, 2017; and Lockheed-Martin, "F-35 Lightning II: Turkey Industrial Participation" (Fort Worth: Lockheed-Martin, 2015): 1–2; https://www.f35.com/global/participation/turkey-industrial-participation; accessed June 6, 2017.

70. See Raphael S. Cohen, and Gabriel M. Scheinmann, "Can Europe Fill the Void in U.S. Military Leadership?," *Orbis*, 58 (1) (Winter 2014): 39–54; https://doi.org/10.1016/j.orbis.2013.11.002; Jason Reifler, Harold D. Clarke, et al. "Prudence, Principle and Minimal Heuristics: British Public Opinion Toward the Use of Military Force in Afghanistan and Libya," *The British Journal of Politics and International Relations*, 16 (1) (February 2014): 28–55; https://doi.org/10.1111/1467-856X.12009; Eric S. Lin, Hamid E. Ali, and Yu-Ling Lu, "Does Military Spending Crowd Out Social Welfare Expenditures?: Evidence from a Panel of OECD Countries," *Defense and Peace Economics*, 26 (1) (2015): 33–48; https://doi.org/10.1080/10242694.2013.848576; and Bastien Irondelle, Frédéric Mérand, and Martial Foucault, "Public Support for European Defence: Does Strategic Culture Matter?," *European Journal of Political Research*, 54 (2) (May 2015): 363–383; https://doi.org/10.1111/1475-6765.12090.

References

Barrie, Douglas. "Dutch JSF Deal a Blow to European Fighters." *Aviation Week and Space Technology*, 156 (7) (February 18, 2002): 26–27.

———. "Lightning Strike." *Aviation Week and Space Technology*, 165 (20) (November 20, 2006): 99.

Bassford, Matt, Maarten van den Voort, et al. *The Netherlands F-16 Comparative Analysis: An Evaluation of the Process* (Santa Monica: Rand Corporation, 2008): 17–18, 22, 24–25, 35, 44. http://www.rand.org/content/dam/rand/pubs/technical_reports/2008/RAND_TR656.pdf. Accessed April 18, 2017.

Bekdil, Burak Ege. "Turkey to Order New F-35 Lightning II Jets." *Defense News* (October 31, 2016): 1–2. http://www.defensenews.com/articles/turkey-to-place-new-f-35-order. Accessed June 6, 2017.

Beng, Koh Eng. *Integrated Strike Exercise Adds Thinking Enemy* (Singapore: Ministry of Defence, 2013): 1–2. https://www.mindef.gov.sg/imindef/resourcelibrary/cyberpioneer/topics/articles/news/2013/dec/11dec13_news.html#.WMgYgIWcF9A. Accessed April 21, 2017.

Cheng, Dean. *Getting Serious About Taiwan's Air Power Needs* (Washington, DC: The Heritage Foundation, 2011). http://www.heritage.org/research/reports/2011/10/getting-serious-about-taiwans-air-power-needs. Accessed June 5, 2017.

Cohen, Raphael S., and Gabriel M. Scheinmann. "Can Europe Fill the Void in U.S. Military Leadership?" *Orbis*, 58 (1) (Winter 2014): 39–54. https://doi.org/10.1016/j.orbis.2013.11.002.

"Competitive Pressure." *Aviation Week and Space Technology*, 174 (8) (February 27, 2012): 29.

Cyr, Arthur I. "Turkey's Continuing Role as a Pivotal Ally in a Rapidly Changing Region." *Orbis*, 59 (2) (2015): 215–232. https://doi.org/10.1016/j.orbis.2015.02.001.

Daniels, Jeff. "South Korea, Japan May Put the F-35B Stealth Fighter on Combat-Capable Ships." *CNBC* (December 28, 2017): 1–4. https://www.cnbc.com/2017/12/28/south-korea-japan-may-put-f-35b-stealth-jets-on-combat-capable-ships.html. Accessed January 4, 2018.

"Despite Tensions With U.S. Lockheed Prepares to Hand Over F-35s to Turkey." *Sputnik News* (July 20, 2016): 1–3. https://sputniknews.com/military/201607201043363472-turkey-coup-f-35s/. Accessed June 6, 2017.

"European Leaders Breather Easier as Rutte Routs Wilders." *Deutsche Welle* (March 16, 2017): 1–4. http://www.dw.com/en/european-leaders-breathe-easier-as-rutte-routs-wilders/a-37957091. Accessed April 23, 2017.

Faruolo, Lianna Nicole. *An Update on the Taiwan Defense Situation (2011–2012)* (Fort Leavenworth, KS: Foreign Military Studies Office, 2012): 7.

Ferry, Tim. "Taiwan's Aviation Industry: Readying for Takeoff" (Taipei: American Chamber of Commerce in Taipei, December 16, 2015): 1–5. http://topics.amcham.com.tw/2015/12/taiwans-aviation-industry-readying-for-takeoff/. Accessed June 5, 2017.

Gady, Franz-Stefan. "Taiwan Pushes for Sale of F-35 Fighter Jets." *The Diplomat* (May 3, 2017): 1–2. https://thediplomat.com/2017/05/taiwan-pushes-for-sale-of-f-35-fighter-jets/. Accessed January 4, 2018.

Gravemaker, Anno. "Dutch Parliament Approves First F-35 Production Order." *Flightglobal* (March 3, 2015): 1. http://www.flightglobal.com/news/articles/dutch-parliament-approves-first-f-35-production-order-409673/. Accessed April 17, 2017.

Güvenç, Serhat, and Lerna K. Yanik. "Turkey's Involvement in the F-35 Program: One Step Forward, Two Steps Backward?" *International Journal*, 68 (1) (Winter 2012–13): 119–120. https://doi.org/10.1177/002070201306800108.

H.R. 5515: National Defense Authorization Act For Fiscal Year 2019. 2018. https://www.govinfo.gov/content/pkg/BILLS-115hr5515eh/pdf/BILLS-115hr5515eh.pdf; 987–990. Accessed August 14, 2018.

Hartung, William D. *Promising the Sky: Pork Barrel Politics and the F-35 Combat Aircraft* (Washington, DC: Center for International Policy, 2014): 17. http://www.ciponline.org/images/uploads/publications/Hartung_IPR_0114_F-35_Promising_the_Sky_Updated.pdf. Accessed April 12, 2017.

Hay, David. *Japan's Strategic Re-Posture: Prime Minister Abe and the Implications for the Japan-US Alliance and Regional Security* (Canberra: Australian Defence College, Centre for Defense and Strategic Studies, 2014): 12. http://www.defence.gov.au/ADC/Publications/IndoPac/Hay final paper (2).pdf. Accessed May 24, 2017.

Hickey, Dennis V. "Dilemmas for US Strategy: Imbalance in the Taiwan Strait." *Parameters*, 43 (3) (Autumn 2013): 43–53.

Hoon, Cho Nam. "Status of the 2017 ROK Defense Budget and Its Implications." *ROK Angle: Korea's Defense Policy #147*. 2017. www.kida.re.kr/cmm/viewBoardImageFile.do?idx=21723. Accessed May 24, 2017.

Irondelle, Bastien, Frédéric Mérand, and Martial Foucault. "Public Support for European Defence: Does Strategic Culture Matter?" *European Journal of Political Research*, 54 (2) (May 2015): 363–383. https://doi.org/10.1111/1475-6765.12090.

Keck, Zachary. "America's Air-Sea Battle Plan in Korea." *The Diplomat* (June 20, 2014a): 1–2. http://thediplomat.com/2014/06/americas-air-sea-battle-plan-in-korea/. Accessed May 24, 2017.

———. "South Korea to Purchase F-35s." *The Diplo*mat (March 25, 2014b): 1. http://thediplomat.com/2014/03/south-korea-to-purchase-f-35s/. Accessed May 24, 2017.

Korea Aerospace Industries Association. *Korea Aerospace Industry 2015* (Seoul: Korea Aerospace Industries Association, 2015): 4–7. http://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/28150507103312/28150507103312_3.pdf. Accessed May 24, 2017.

Lee, Joyce. "South Korea Boosts Air Defenses With About $6.8 Billion Budget for F-35s." *Reuters* (March 24, 2014): 1–3. http://www.reuters.com/article/us-korea-jets-idUSBREA2N07220140324. Accessed May 24, 2017.

Lee, Taehon, James Griffith, and Joshua Berlinger. "U.S. Fighter Jets Stage Mock Bombing Drill Over Korean Peninsula." *CNN Politics* (August 31, 2017): 1–5. http://www.cnn.com/2017/08/31/politics/us-bombers-korean-peninsula/index.html. Accessed January 4, 2018.

Lin, Eric S., Hamid E. Ali, and Yu-Ling Lu. "Does Military Spending Crowd Out Social Welfare Expenditures?: Evidence from a Panel of OECD Countries." *Defense and Peace Economics*, 26 (1) (2015): 33–48. https://doi.org/10.1080/10242694.2013.848576.

Liu, Pei-Leen. "The Development of a Military Aircraft Industry for Latecomers: The Case of Taiwan." *The Korean Journal of Defense Analysis*, 26 (1) (March 2014): 97–116.

Lockheed Martin. *F-35 Lightning II: Turkey Industrial Participation* (Fort Worth: Lockheed Martin, 2015a): 1–2. https://www.f35.com/global/participation/turkey-industrial-participation. Accessed June 6, 2017.

———. *First F-35 for Norway Progressing Towards Delivery* (Fort Worth: Lockheed Martin, February 6, 2015b): 1–2. https://www.f35.com/news/detail/first-f-35a-for-norway-progressing-towards-delivery. Accessed April 20, 2017.

———. *Norway F-35 Partnership* (Fort Worth: Lockheed Martin, 2015c): 1–2. https://www.f35.com/global/participation/norway. Accessed April 20, 2017.

———. *Turkey to Order Four More F-35 Fighter Jets* (Fort Worth: Lockheed-Martin, January 7, 2015d): 1. https://www.f35.com/news/detail/turkey-to-order-four-more-f-35-fighter-jets. Accessed June 6, 2017.

———. *Lockheed Martin F-35A Icy Runway Testing for Norwegian Drag Chute Underway in Alaska* (Fort Worth: Lockheed Martin, November 27, 2017): 5–7. https://www.f35.com/news/detail/lockheed-martin-f-35a-icy-runway-testing-for-norwegian-drag-chute-underway. Accessed January 4, 2018.

Lok, Joris Janssen. "Growing the Gripen." *Aviation Week and Space Technology*, 68 (26) (June 30, 2008): 42–43.

Machi, Vivienne. "Turkish Missile Could be Integrated on F-35." *National Defense* (December 15, 2017): 1–3. http://www.nationaldefensemagazine.org/articles/2017/12/15/turkish-missile-could-be-integrated-on-f35. Accessed January 4, 2018.

Mecham, Michael. "Industry Outlook." *Aviation Week and Space Technology*, 159 (14) (October 6, 2003): 27.

Mehta, Aaron. "Singapore Eyes F-35 for 2030 Time Frame." *Defense News* (October 3, 2016): 1. https://www.defensenews.com/air/2016/10/03/singapore-eyes-f-35-for-2030-time-frame/. Accessed June 11, 2018.

Mizokami, Kyle. "F-35 Friendly Norwegian Strike Missile Tested Over Utah." *Popular Mech*anics (December 22, 2016): 1–2. http://www.popularmechanics.com/military/weapons/a24459/norwegian-strike-missile-tested-over-utah/. Accessed April 20, 2017.

Netherlands Aerospace Centre. *Hardened Aircraft Shelters in the Netherlands Suitable for F-35 Aircraft* (Amsterdam: Netherlands Aerospace Centre, 2016): 1–2. http://www.nlr.org/news/hardened-aircraft-shelters-on-air-force-bases-in-the-netherlands-suitable-for-f-35-aircraft/. Accessed April 23, 2017.

Netherlands. Court of Audit. *Joint Strike Fighter Exit Costs* (The Hague: Court of Audit, 2012): 17–18, 20–22. https://english.rekenkamer.nl/binaries/rekenkamer-english/documents/reports/2012/10/24/cost-of-withdrawing-from-the-joint-strike-force-programme/Report+JSF+met+cover.pdf. Accessed January 4, 2018.

———. *Validation of the Policy Document 'In the Interests of the Netherlands* (The Hague: Court of Audit, 2013): 26, 30. https://english.rekenkamer.nl/binaries/rekenkamer-english/documents/reports/2013/09/19/validation-of-the-policy-document-in-the-interests-of-the-netherlands/Report+Validation+of+the+policy+document+In+the+Interests+of+the+Netherlands.pdf. Accessed March 13, 2017.

Netherlands. House of Representatives. *F-35/JSF* (The Hague: House of Representatives, 2016): 1–2. https://www.houseofrepresentatives.nl/dossiers/f-35jsf. Accessed April 18, 2017.

Netherlands. Ministry of Defence. *Director of F-35 Programme: Price of F-35 to Fall* (The Hague: Ministry of Defence, January 15, 2015): 1–2. http://www.defensie.nl/english/latest/news/2015/01/15/director-of-f-35-programme-%E2%80%98price-of-f-35-to-fall%E2%80%99. Accessed April 18, 2017.

Neubauer, Sigurd. *Norway, the Joint Strike Fighter Program and Its Implications for Transatlantic Defense Cooperation* (Oslo: Norwegian Institute of International Affairs, 2015): 1–2. https://www.files.ethz.ch/isn/195614/NUPI_Policy_Brief_27_15_Sigurd_Neubauer.pdf. Accessed April 20, 2017.

Norway. *HM The King's Report to the Storting on the State of the Realm and the Administration of the Government During the Period Since the Previous Report* (Oslo: Norwegian Government, October 15, 2009): 15. https://www.regjeringen.no/en/aktuelt/hm-the-kings-report-to-the-storting-on-t/id579235/. Accessed April 20, 2017.

"Norway Rejects Gripen, Stays with F35 JSF." *Aviation Week and Space Technology*, 169 (20) (November 24, 2008): 16.

Norway. Ministry of Defence. *Norway Releases New Defence Plan; Emphasises Improved Operational Capability, Personnel and Updated F-35 Procurement Schedule* (Oslo: Ministry of Defence, March 23, 2012): 3–4. https://www.regjeringen.no/en/aktuelt/norway-releases-new-defence-white-paper-/id676237/. Accessed April 20, 2017.

———. *The F-35 Combat Aircraft: Important to "Keep up the Good Progress"* (Oslo: Ministry of Defence, January 20, 2014a): 1–3. https://www.regjeringen.no/en/aktuelt/the-f-35-combat-aircraft-important-to-ke/id748968/. Accessed April 20, 2017.

———. *Government Proposes 3.4% Defence Budget Increase in 2015* (Oslo: Ministry of Defence, October 13, 2014b): 1–4. https://www.regjeringen.no/en/aktuelt/Proposing-34-Defence-Budget-Increase-in-2015/id2005697/. Accessed April 20, 2017.

———. *Future Acquisitions for the Norwegian Armed Forces 2015–2023* (Oslo: Ministry of Defence, 2015): 6–7. https://www.regjeringen.no/globalassets/departementene/fd/dokumenter/rapporter-og-regelverk/acquisitions-2015-2023.pdf. Accessed April 20, 2017.

———. *Army Summit 2016 – Defence Minister Ine Eriksen Søreide's Opening Remarks* (Oslo: Ministry of Defence, September 20, 2016): 3, 5. https://www.regjeringen.no/en/aktuelt/army-summit-2016%2D%2D-defence-minister-ine-eriksen-soreides-opening-remarks/id2511838/. Accessed April 20, 2017.

———. *Capable and Sustainable: Long-Term Defence Plan* (Oslo: Ministry of Defence, June 20, 2016b): 7. https://www.regjeringen.no/globalassets/departementene/fd/dokumenter/rapporter-og-regelverk/capable-and-sustainable-ltp-english-brochure%2D%2D-print.pdf. Accessed April 20, 2017.

Norway. Prime Minister Erna Solberg. *The Arrival in Norway of the First F-35 Lightning II Jets* (Oslo: Office of the Prime Minister, November 10, 2017): 1–3. https://www.regjeringen.no/en/aktuelt/the-arrival-in-norway-of-the-first-f-35-lightning-ii-jets/id2578604/. Accessed January 4, 2018.

Osborne, Tony. "Anatolian Ambitions." *Aviation Week and Space Technology*, 175 (19) (June 10, 2013): 48.

Osborne, Tony, and Amy Butler. "Difficult Choices." *Aviation Week and Space Technology*, 175 (33) (September 23, 2013): 34.

Perrett, Bradley. "High Anxiety." *Aviation Week and Space Technology*, 173 (20) (June 6, 2011): 20.

———. "Another KF-X Enemy." *Aviation Week and Space Technology*, 175 (6) (February 18, 2013): 23.

Perrett, Bradley, and Amy Butler. "Seoul Survivor." *Aviation Week and Space Technology*, 175 (34) (September 30, 2013): 28.

Pieters, Janene. "Dutch Gov't Maybe Can't Afford Last Three JSF Fighter Jets." *NL Times* (November 30, 2017): 1. https://nltimes.nl/2017/11/30/dutch-govt-maybe-cant-afford-last-three-jsf-fighter-jets. Accessed January 4, 2018.

Pittaway, Nigel. "U.S. Program Chief: Singapore Nearing F-35 Buy." *Defense News* (February 25, 2015): 1–2. http://www.defensenews.com/story/defense/show-daily/avalon/2015/02/24/avalon-australia-f35-fms-bogdan-deeble-singapore/23927983/. Accessed April 21, 2017.

Public Law 96-8. "Taiwan Relations Act." 93 *U.S. Statutes at Large*, 14–21. 1979. https://www.gpo.gov/fdsys/pkg/STATUTE-93/pdf/STATUTE-93-Pg14.pdf. Accessed January 4, 2018.

Reifler, Jason, Harold D. Clarke, et al. "Prudence, Principle and Minimal Heuristics: British Public Opinion Toward the Use of Military Force in Afghanistan and Libya." *The British Journal of Politics and International Relations*, 16 (1) (February 2014): 28–55. https://doi.org/10.1111/1467-856X.12009.

Rubin, Michael. “Can Turkey Be Trusted With F-35s?” *Commentary* (July 20, 2017): 1–2. https://www.commentarymagazine.com/foreign-policy/middle-east/turkey/can-turkey-be-trusted-with-f-35s/. Accessed January 4, 2018.

Shankar, Sreekanth, James Phang, Ng Guo Feng, and Tan Peng Yu. “Sustaining a Strong and Capable RSAF for the Future.” *Pointer* 2016 *Supplement*, 16. https://www.mindef.gov.sg/content/dam/imindef_media_library/graphics/pointer/PDF/2016/af-supp2016/af-supp2016_full.pdf. Accessed April 21, 2017.

Shim, Elizabeth. “Taiwan Developing Next-Generation Fighter Jets, Defense Minister Says.” *UPI* (January 24, 2017): 2–4. http://www.upi.com/Top_News/World-News/2017/01/24/Taiwan-developing-next-generation-fighter-jets-defense-minister-says/9431485284790/. Accessed June 5, 2017.

Sigelman, Lara, and James Drew. “Tumult in Turkey Puts F-35 at Risk.” *Aviation Week and Space Technology*, 178 (15) (July 25, 2016): 1.

Singapore Budget. *Summary Table of Revenues and Expenditure Estimates: Total Estimates Outlays for FY 2017 by Head of Expenditure* (Singapore: Singapore Budget, 2017): 5. https://www.singaporebudget.gov.sg/data/budget_2017/download/05 Government Expenditure 2017.pdf. Accessed April 21, 2017.

Singapore. Economic Development Board. *Aerospace Engineering Singapore* (Singapore: Economic Development Board, 2017a): 1–2. https://www.edb.gov.sg/content/edb/en/industries/industries/aerospace-engineering.html. Accessed April 21, 2017.

———. *Aerospace: Singapore-Asia’s Aerospace Hub* (Singapore: Economic Development Board, 2017b). https://www.edb.gov.sg/content/dam/edb/en/resources/factsheetsnew/Aerospace-Engineering.pdf. Accessed April 21, 2017.

Singapore. Ministry of Defence. *Speech by Minister for Defence Dr. Ng Eng Hen at the Committee of Supply Date 2013* (Singapore: Ministry of Defence, 2013): 2.

Singapore. Ministry of Finance. *Budget: Revenue and Expenditure Estimates* (Singapore: Ministry of Finance, 2017): 63–66. https://www.singaporebudget.gov.sg/data/budget_2017/download/25%20MINDEF%202017.pdf. Accessed June 11, 2018.

Sobolev, Sebastian. “F-35 Back in the Fight for South Korea’s FX-III Competition.” *Avascent Analytics Blog* (September 24, 2013): 1–2. http://www.avascent.com/2013/09/f-35-back-in-the-fight/. Accessed May 24, 2017.

South Korea. Ministry of National Defense. *2012 Defense White Paper* (Seoul: Ministry of National Defense, 2012). http://www.mnd.go.kr/cop/pblictn/selectPublicationUser.do?siteId=mndEN&componentId=51&categoryId=0&publicationSeq=585&pageIndex=1&id=mndEN_031300000000. Accessed May 24, 2017.

———. *2014 Defense White Paper* (Seoul: Ministry of National Defense, 2014): 49–55. http://www.mnd.go.kr/cop/pblictn/selectPublicationUser.do?siteId

=mndEN&componentId=51&categoryId=0&publicationSeq=689&pageIndex=1&id=mndEN_031300000000. Accessed May 24, 2017.

Statistical Yearbook of the Republic of China, 2015 (Taipei: Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, Republic of China, 2016): 16. http://ebook.dgbas.gov.tw/public/Data/610281138403HCL2D3O.pdf. Accessed June 5, 2017.

Stockholm International Peace Research Institute (SIPRI). *Military Expenditure Database* (Stockholm: SIPRI, 2017). https://www.sipri.org/sites/default/files/SIPRI-Milex-data-1988-2015.xlsx. Accessed June 5, 2017.

Taiwan Aerospace Industry Association. *Member Product* (Taipei: Taiwan Aerospace Industry Association, 2015): 1–6. http://www.taia.org.tw/en/product.asp. Accessed June 5, 2017.

"Taiwan Still Hopes to Buy F-35 Fighters from U.S.: Defense Official." *Pacific Sentinel* (August 21, 2014): 1–2. http://pacificsentinel.blogspot.de/2014/08/news-story-taiwan-still-hopes-to-buy-f.html. Accessed March 24, 2017.

Taiwan. Air Force Command Headquarters. *History* (Taipei: Air Force Command Headquarters, February 24, 2017): 1. http://air.mnd.gov.tw/english/Webpage.aspx?entry=354. Accessed June 5, 2017.

Taiwan. Ministry of Economic Affairs. Department of Statistics. *Economic Indicators: B-6 Export by Commodity* (Taipei: Ministry of Economic Affairs, 2018): 9. https://www.moea.gov.tw/Mns/main/content/wHandMenuFile.ashx?file_id=18159. Accessed June 11, 2018.

Taiwan. Ministry of National Defense. *National Defense Report* 2015 (Taipei: Ministry of National Defense, 2015): 25, 41–42, 52, 68, 78, 121. https://china.usc.edu/sites/default/files/article/attachments/taiwan-2015-national-defense-report.pdf. Accessed June 11, 2018.

Tan, Andrew T.H. "The Implications of Taiwan's Declining Defense." *Asia-Pacific Review*, 21 (1) (2014): 41–62. https://doi.org/10.1080/134390006.2014.921125.

"The Dutch Government Says." *Aviation Week and Space Technology*, 165 (14) (October 9, 2006): 77.

"The F-35 Joint Strike Fighter." *Aviation Week and Space Technology*, 165 (11) (September 18, 2006): 57.

The Global Arms Industry in 2030 (And Beyond) (Singapore: S. Rajaratnam School of International Studies, 2014): 22. http://www.rsis.edu.sg/wp-content/uploads/2015/01/ER150123_Global_Arms_Industry.pdf. Accessed April 21, 2017.

Tiezzi, Shannon. "Why the U.S. Will Not Sell Advanced Fighters to Taiwan." *The Diplomat* (January 11, 2014): 1. http://thediplomat.com/2014/01/why-the-us-will-not-sell-advanced-fighters-to-taiwan/. Accessed June 5, 2017.

U.S. Congress. House Committee on Foreign Affairs. Subcommittee on Europe, Eurasia, and Emerging Threats. *The Future of Turkish Democracy* (Washington, DC: GPO, 2014). http://purl.fdlp.gov/GPO/gpo52563. Accessed June 6, 2017.

U.S. Defense Security Cooperation Agency. *Korea-F-35 Joint Strike Fighter Aircraft* (Washington, DC: DSCA, April 3, 2013): 1–2. http://www.dsca.mil/sites/default/files/mas/korea_13-10_0.pdf. Accessed May 24, 2017.

———. *News Release: Turkey—Joint Direct Attack Munitions (Corrected)* (Washington, DC: DSCA, December 7, 2015): 1–2. http://www.dsca.mil/sites/default/files/mas/turkey_14-01_corrected.pdf. Accessed June 6, 2017.

U.S. Department of Commerce. International Trade Administration. *Leading Sectors for U.S. Export Investment: Aerospace Industry* (Washington, DC: International Trade Administration, 2016): 1–3. https://www.export.gov/article?id=Korea-Aerospace-Industry. Accessed May 24, 2017.

U.S. Department of Defense. *American Turkish Council: Remarks as Delivered by Secretary of Defense, William S. Cohen, Grand Hyatt Hotel, Washington, DC, March 31, 2000* (Washington, DC: DOD, 2000): 1–2. http://archive.defense.gov/Speeches/Speech.aspx?SpeechID=549. Accessed June 6, 2017.

———. Office of the Deputy Undersecretary of Industrial Policy. *JSF International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers* (Washington, DC: DOD, 2003): D-1 to D-15. http://permanent.access.gpo.gov/lps61713/Acr9B.tmp.pdf. Accessed April 18, 2017.

———. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China* (Washington, DC: DOD, 2016): 109. https://www.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf. Accessed June 5, 2017.

U.S. Department of State. *Treaties and Other International Acts Series 02-810, Defense Joint Strike Fighter Program: Agreement Between the United States of America and Turkey Supplementing the Memorandum of Understanding of January 17, 2001* (Washington, DC: Department of State, 2013): 5–7, 10. http://purl.fdlp.gov/GPO/gpo39157. Accessed June 6, 2017. www.metric-conversions.org/.

———. *Country Reports on Human Rights Practices: Turkey* (Washington, DC: U.S. Department of State, 2016). https://www.state.gov/documents/organization/265694.pdf. Accessed June 6, 2017.

Wall, Robert. "SOM Strides." *Aviation Week and Space Technology*, 173 (33) (September 19, 2011): 43.

———. "Joining Up." *Aviation Week and Space Technology*, 174 (12) (April 2, 2012): 40.

Wang, Kent. "Why The U.S. Should Sell Advanced Fighters to Taiwan." *The Diploma*t (January 10, 2014): 1. http://thediplomat.com/2014/01/why-the-us-should-sell-advanced-fighters-to-taiwan/. Accessed June 5, 2017.

"Weight on Wheels" for Norwegian Armed Forces' First F-35 (Fort Worth: Lockheed Martin, April 16, 2015): 3. https://www.f35.com/news/detail/weight-on-wheels-for-norwegian-armed-forces-first-f-35. Accessed April 20, 2017.

Wong, Kelvin. *F-35 Joint Strike Fighter: Singapore's Next-Generation Fighte*r? (Singapore: S. Rajaratnam School of International Studies, 2013): 1–2. http://www.rsis.edu.sg/wp-content/uploads/2014/07/CO13048.pdf. Accessed April 21, 2017.

Wong, Yen and Kent Wang. "Sell Advanced Fighters to Taiwan." *The Hill* (February 11, 2017): 1–2. http://thehill.com/blogs/congress-blog/foreign-policy/318994-sell-advanced-fighters-to-taiwan. Accessed June 5, 2017.

CHAPTER 10

Conclusion

The JSF's diverse international experiences reflect the cost of high technology and delays inherent in multinational defense acquisitions. It also reflects the close intersections between military spending and the aerospace industry as the following quotation demonstrates:

> The economic aspect of airpower extends beyond government expenditures. The aircraft industry, given the very high cost per unit produced, is a significant economic force in itself. Consumption of materials, engineering skill, power, and general labor sends ripples through the economy. In recent times, costs and technical sophistication have climbed to such heights that very few nations still have an aircraft industry sufficient to meet all their needs, both military and civil. Hence the aircraft industry itself has become a substantial element of airpower. The procurement or sale of aircraft, whether military or civil, has implications for statecraft.[1]

As of August 2017, 253 JSF aircraft had been fielded and were flying from nine locations in the United States and three locations internationally.[2] An April 2017 GAO report estimated the United States had spent nearly $400 billion on the JSF, making it the DOD's costliest and most ambitious defense program with additional annual expenditures of $12 billion ($276 billion) cumulative through 2038 required for completing development and procurement of 2457 aircraft with overall fleet operational and costs over the aircraft's lifetime expected to exceed $1 trillion.

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7_10

The JSF program is getting closer to operational deployment, but its protracted delays and high price make the willingness of the United States and other countries to engage in such large-scale defense acquisition programs questionable due to continually increasing costs resulting from exponentially growing technological and financial cost requirements of military aircraft. It is also inaccurate to say that defense globalization relaxes international tensions (Fig. 10.1).[3]

The JSF involves 412 US transactions with recipients receiving $825,634,700 in prime contracts and total sub-award transaction contracts in FY 2018.[4] Critical reasons driving these increases costs include the increasing technological costs of cutting-edge military weaponry and the 1990s consolidation of the US defense industry reducing the number of credible combat air fighter contractors to Boeing and Lockheed Martin which has had a deleterious impact on competition and accelerated costs increases.[5]

Additional factors describing the negative impact of defense acquisition are documented in a 2016 *Foreign Affairs* article by House Armed Services Committee Chair Rep. Mac Thornberry (R-TX) and Andrew Krepinevich of the Center for Strategic and Budgetary Assessment who assert:

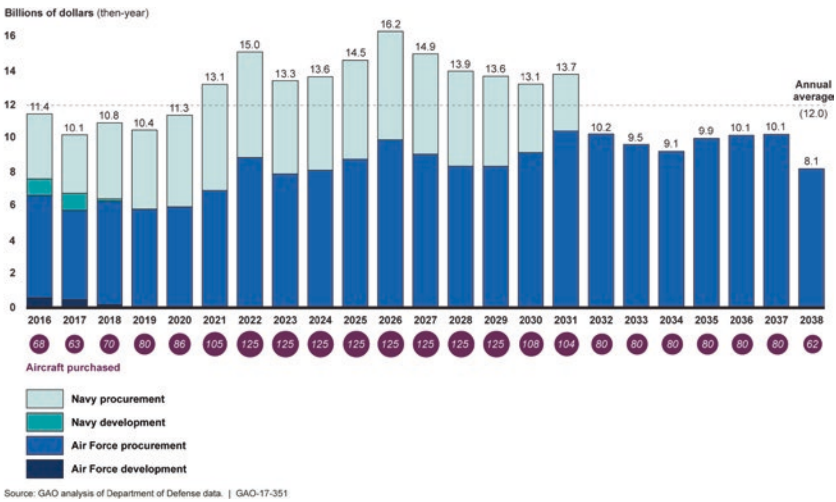

Fig. 10.1 Joint strike fighter budgeted development and procurement costs by service. Source: U.S. Government Accountability Office 2017

> Currently, … the United States takes far longer than its adversaries to get new equipment from the drawing board into the hands of its men and women in uniform—more than a decade, in many cases. In large part, that's because the Pentagon often seeks to push new systems' performance characteristics to an extreme. Projects incur costs overruns when their overseers attempt to incorporate new technologies before they are mature, wasting both time and money while troops make do with older equipment. Compounding the problem, Uncle Sam to often spends, relatively speaking, thousands of dollars ensuring that it doesn't get cheated out of nickels and dimes. It's past time to reform that system by setting more realistic requirements and speeding new equipment into the field.[6]

This work has documented JSF's operational problems and financial costs on a multinational scale. A simple conclusion readers might draw from the JSF experience is that it should be canceled. A persuasive case could be made for cancelation on a strictly monetary basis due to the program's delays and cost overruns. The difficulty with reaching such a conclusion is that JSF's significant US and multinational commitment to this program have essentially made it "too big to fail" given its international scope, the amount of money and political capital spent, and the need for the United States and its allies to retain an air combat competitive edge in future military operations. In the United States, the JSF's workforce supports direct and indirect jobs for over 170,000 individuals in 46 states and Puerto Rico. Similar characteristics influence JSF's workforce and political influence in other countries demonstrated in the following table (Table 10.1).

JSF critics need to present economically and militarily credible alternatives to address emerging US and allied jet fighter combat operational needs against emerging threats beyond maintaining existing combat aircraft fleets.[7]

Table 10.1 Selected JSF international workforce and contract statistics

Australia	50 companies	$800 million contracts
Canada	50,000 jobs	$1 billion contracts
Denmark		$356 million contracts
Italy	750+ jobs	$1.35 billion contracts
Netherlands	27 companies	$750 million contracts
Turkey	10 companies	$12 billion potential contracts
United Kingdom	24,000 jobs	Building 15% of planned JSF Fleet

The following 2013 assessment of defense industry costs is noteworthy for acquisition reform suggestions it makes:

> Decision processes for major DoD investments contrast sharply with those in the private sector. Senior managers in industry routinely deploy financial metrics in choosing among spending proposals. Unreliable as these may be, they help decision makers mediate inter-organizational competition by placing competing proposals on a common basis. DoD has no similar way to compare proposed new weapons systems put forward by the military services. Many such systems have similar functions, yet as investments are incommensurable. In the absence of useful methods for comparing weapons acquisition proposals, and given the political malleability of "national security," the services have usually been able to insist upon the weapons they want.
>
> In the absence of workable schemes for evaluating requests, and with the services constantly competing for missions and for resources to accomplish these missions, the quest for technologically complex super-weapons will likely continue. Meaningful reform would have to begin with legislation that reduced the influence of the individual services over choice of weapons, and increased the power of civilian officials. If discretionary choices must be made, it is better that they may be made by civilians to take a broad view. Greater institutional power for OSD and less for the services would not make acquisition decisions any easier. Certainly it would do nothing to mitigate the analytical limitations described in this paper. Even so, reducing the influence of the more parochial factions in DoD would increase the likelihood of choices based on reason rather than wishfulness.[8]

US military equipment with the JSF's capabilities will inevitably be of acute interest to competitor countries. JSF design was targeted by China as early as 2007 and the results of such hacking can be shown in the design of emerging Chinese jet fighters including the J-31. Russian espionage has also sought to target JSF technologies and capabilities and incorporate such theft into their own jet fighter assets such as the SU-35.[9]

The United States and its allies must have a next-generation fighter to counter emerging Chinese developments in A2/AD assets seeking to enhance freedom of maneuver and access for their own forces while preventing the United States from using its power projection over Chinese territory, striking against US logistical assets, and requiring the United States to fight its way into the Western Pacific theater of operations in a way it has not had to since World War II[10]; Russian assertiveness demonstrated by its coercive energy "diplomacy"; interventions in Ukraine, Crimea, and Syria; increasing penetrations of Western airspace;

attempts to dominate the High North region which will require Moscow to develop hypersonic weapons against emerging US and allied weapons threats, and pivot to the East which sees it increasingly important to its security interests due to its mineral resources; increasing cooperation with China; Japan's increasing assertiveness; and Russia's desire to detach Japan from the United States[11]; and the imperative for an air superiority capability if military operations need to be conducted against Beijing, Moscow, Pyongyang, Tehran, and transnational terrorist organizations such as Daesh.[12]

Military history also demonstrates the imperative to maintain and increase technological capability against potential enemies. The misplaced French trust in the Maginot Line as a security guarantor against a resurgent German military is a particularly compelling example. Western nations should not myopically assume that China, Russia, or other countries will fail to take advantage of emerging military airpower technologies or exercise restraint in their military actions while Western nations struggle with economic constraints and think war is no longer a valid international political or security option. The march of military innovation and technology is inexorable and Western countries must maintain their ability to retain technological and operational superiority against enemies who do not share their moral values, political interests, and perceptions of national and international security.

Assessing military and technological developments is also incumbent on the United States and its allies as demonstrated by historical experience and contemporary and emerging operational developments and conventional and unconventional threats such as those posed by China and North Korea in the Asia-Pacific and Russia in Eastern Europe, the Mideast, and potentially the Asia-Pacific. The increasing volatility in the Asia-Pacific has been described by Australian Strategic Policy Institute Executive Director Peter Jennings, who contends the risk of military conflict over Asia-Pacific flashpoints is growing quickly; it is uncertain whether military clashes at sea or over sensitive borders can be contained quickly by major powers, that regional military forces have more accurate and long-range weapons, that the region faces strategic danger comparable to the late 1940s and the Vietnam War, that North Korean brinksmanship and provocations may be based on the mistaken view that Japan, South Korea, and the United States will back down, that an explosive mix of Chinese nationalism and overconfidence in their military could produce a serious military incident which could be exacerbated by the Trump Administration's inexperience.[13]

The aging fleet of US jet fighter aircraft is documented by Navy E-A6 Prowler aircraft having a fleet age of 27, that service's F/A-18 A-D Hornet's fleet age being 27.5 years, and its F/A 18 E-F Hornet's fleet age of 13.4 years demonstrates this concern. The Air Force's A-10 ground attack aircraft fleet age is 33, the F-16's is 24.9 years, the F-15's age is 27.7 years, and the Marine Corps F/A-18 A-D's fleet age of 23.5 years demonstrates that the US fighter fleet is reaching the end of its operational effectiveness against emerging military aviation threats. Budget constraints caused by sequestration have also hindered the US ability to maintain a jet fighter capability to deal with emerging threats.[14]

This military technological revolution also applies to jet fighters and their combat operations. While the JSF is classified as a fifth-generation aircraft, military strategists and technologists are already discussing sixth-generation aircraft. Definitions of these aircraft are vague, but could include space-based aircraft, unmanned systems, and platforms which could replace the F/A-18 E and F series planes whose lifespans are expected to end in 2035. They could also include hunting packs of drones which could fight along manned fighters, artificial intelligence, areas spanning networking and communications, controlling the electromagnetic spectrum and sensing along the spectrum, and the roles space assets could play in military operations. US sixth-generation programs involve the DARPA, Air Force, and Navy and are known as the Air Dominance Initiative. This image represents a hypothetical image of a sixth-generation fighter.[15]

The JSF program demonstrates the limits of expensive defense programs and of multinational joint defense acquisition programs. A 2013 Rand Corporation study revealed that joint defense acquisition programs have produced higher acquisition cost growth rates than single-service aircraft programs and not produced life cycle cost savings; increase difficulty in joint cost outcomes due to problems in reconciling divergent military service requirements while also increasing programmatic technical complexity and risk; have contributed to a shrinking combat aircraft industrial base; and could potentially increase operational and strategic risk to warfighters. Consequently, the US Government should work to create an expanded jet fighter domestic industrial base to expand competition and lower costs in these programs through tax incentives and procurement policy reforms by amending legislation such as the 2009 Weapons Systems Acquisition Reform Act.[16]

Many contend that the emergence of UAVs eliminates the need for manned combat aircraft such as jet fighters.[17] UAVs, like other military tools, have limits as many observers have pointed out. A 2015 article in *Joint Force Quarterly (JFQ)* stresses the critical importance of human-human interaction on the battlefield which is essential for interacting with local populations and enemy forces such as captured soldiers. This analysis also maintains that remote control requires connectivity which is not guaranteed on present or future battlefields.[18]

Technology will change military performance requirements by requiring sensors and systems capable of developing hardware and software to improve commander and operator situational awareness. Herr notes:

> the F-35 pilot interface does not primarily rely upon a heads-up display. Rather the information display is built into the helmet so that wherever the pilot looks the system provides information. Even looking down provides a view of the ground from cameras overlaid on the visual, such as waypoints and enemy and friendly systems. While rife with problems throughout its development, by integrating multiple data feeds into the visual picture, the final version will hopefully enable the pilot to make better tactical decisions.[19]

This analysis also noted human factors limiting the ability of UAV operators to sustain attention and accuracy when conducting military operations. In an Air Force study, personnel were asked to perform a task requiring them to monitor a computer screen and identify whether small icons represented planes flying toward or away from each other. This study revealed that during the first ten-minute period, accuracy fell about 5% for each additional ten minutes on task until it ended at 40 minutes with individuals at just 85% performance. This proved that despite piloting UAVs from air conditioned rooms in the United States, UAV operators could operate for only a limited time before needing to rest and recover mentally.[20]

Despite the JSF's protracted financial and technical problems and the fiscal constraints facing many JSF partner countries, which have caused them to reduce defense spending, emerging military airpower and geopolitical and technological trends make purchasing the JSF the least problematic military aviation alternative for the US military and its international allies. These trends include the continuing imperative and relevance of human decision-making in conducting military operations, the ongoing commitment of countries such as China, Iran, North Korea, and Russia to increasing their military capabilities and challenging US and allied geopolitical and strategic interests in multiple global arenas including the Arctic, Eastern Europe, the Korean Peninsula, the Persian Gulf, South and East China Seas, and Western Pacific.

It is possible that continuing developments in UAV and space-based weapons technology over subsequent decades may overtake human involvement in military airpower operations and make the JSF the last manned air fighter. Testifying before a November 3, 2015, Senate Armed Services Committee hearing Peter Singer of the New America Foundation (NAF) responded to Senator John McCain's question on whether the JSF is the last manned fighter aircraft by saying he did not know because other countries may continue constructing such aircraft. Singer stressed that US policymakers should make historical parallels with other innovative aircraft such as the British Gloster Gladiator and Spitfire and the US Navy's F-4 Wildcat and admitted he did not believe the United States would be buying the same numbers of combat aircraft in 2025 or 2030 that it is now. Center for Strategic and Budgetary Assessments (CSBA)'s Bryan Clark told the committee it is possible the JSF could be the last purpose-built strike fighter.[21]

There have been simulations of the JSF though the quality of these simulations can be questioned. On December 7, 2015, a submission to the Australian Senate's Foreign Affairs, Defence, and Trade Committee was made by retired RAAF Wing Commander Chris Mills on behalf of AirPower Australia, an organization which has been extremely critical of the JSF. This submission referenced a 2010 simulation conducted by AirPower Australia presenting a 2019 combat scenario over the Taiwan Strait Sea involving the F-22A Raptor and JSF in confrontations against China's SU-35. These simulations maintained that the JSF losses to the SU-35 would be at a ratio of 2.36–1 while the F-22A Raptor would have shot down 2.14 SU-35s for every Raptor which was shot down. This submission went on to claim that if JSFs went into battle against advanced Chinese or Russian aircraft such as the J-20, J-31, and T-50, they would only survive one to two days of combat. The older date of these simulations fails to reflect current JSF technological capabilities, let alone its current capabilities along with the current technological capabilities and skills of Chinese, US, and US-allied pilots.[22]

Another way of measuring the JSF's effectiveness is assessments provided by US and allied country pilots who have flown this aircraft. A 2016

Heritage Foundation study interviewed 31 fighter pilots asking them to compare the JSF's F-35A's maneuverability with the A-10, F-15C, F-15E, and F-16C. Maneuverability categories these pilots were asked to evaluate included:

- Instantaneous turn
- Sustained turn rate
- Responsiveness at slow speeds
- Stack/scissors performance (aerial dogfighting maneuver)
- Ability to recover airspeed.

These pilots were asked to conduct their ratings on a scale of 0–5, with 0 being unsatisfactory and 5 being exceptional. In the A-10 versus JSF comparison the JSF received higher rankings in instantaneous turn, responsiveness at slow speeds, stack/scissors performance, and ability to recover airspeed. Comparing the F-15C versus the JSF saw the JSF receive higher ratings in responsiveness at slow speeds, and stack/scissors performance. The F-15E versus JSF saw the JSF receive higher ratings in instantaneous turn, sustained turn rate, responsiveness at slow speeds, stack/scissors performance, and ability to recover attack speed. The F-16C versus JSF saw JSF receive higher ratings in responsiveness at slow speeds, stack/scissors performance, and ability to recover air speed.[23]

This pilot survey also asked for comparisons of the JSF's performance with the A-10, F-15C, F-15E, and F-16C in areas of beyond visual range (BVR), 9 K' perch setup (covering offensive and defensive maneuvering), butterfly maneuvering, short-range, and tree/vertical flight. The JSF was rated superior to the A-10 with the following rankings (Table 10.2).

Numerous pilots have said the JSF can locate, identify, and triangulate emitter locations faster and with greater precision than the F-16. These pilots have also commented favorably on the JSF's Distributed Aperture System (DAS) within the HMD enabling them to perform near-spherical scans with 20/40 clarity, day or night, and enhancements from the Electro-Optical Targeting System (EOTS) providing precision air-to-air surface targeting capability. Confidence in improvements made to JSF software and engineering has also increased pilot confidence in JSF sensor fusion capability.[25]

Direct comments by JSF pilots also speak favorably of JSF performance. USAF Lt. Col. Matt Hayden of the 56th Fighter Wing at Luke AFB maintains:

Table 10.2 Pilot survey of JSF performance versus other combat aircraft[24]

Pilot aircraft	*Performance maneuver*	*% Choosing F-35A over other aircraft*
A-10	BVR	100
	9K Perch Setup	100
	Butterfly	100
	Short-Range	90
	Tree/Vertical Flight	100
F-15C	BVR	100
	9K Perch Setup	25
	Butterfly	75
	Short-Range	100
	Tree/Vertical Flight	100
F-15E	BVR	100
	9K Perch Setup	100
	Butterfly	75
	Short-Range	100
	Tree/Vertical Flight	100
F-16C	BVR	100
	9K Perch Setup	73
	Butterfly	80
	Short-Range	90
	Tree/Vertical Flight	95
All Surveyed Pilots	BVR	100
	9K Perch Setup	77
	Butterfly	82
	Short-Range	92
	Tree/Vertical Flight	97

> There is nothing that I have seen from maneuvering an F-35 in a tactical environment that leads me to assume that there is any other airplane I would rather be in. I feel completely comfortable and confident taking that airplane into any combat environment.[26]

A series of late 2016 analyses in *The National Interest* forecast that the JSF would fare satisfactorily in a potential conflict with Chinese or Russian Su-35s. An early 2017 Red Flag war game exercise lasting three weeks at Nellis AFB, NV, saw the JSF achieve a 15:1 kill ratio according to the Air Force with reservist JSF pilot Major Jayson Rickard commenting: “We’re striking targets, killing advanced surface-to-air missile, and getting some air-to-air kills.”[27]

British RAF pilot Captain Jonathan Thompson, who has flown the Harrier, praised the intuitiveness of the JSF's hover mode. He mentioned this hover technique was as easy to learn as the Harrier's, that "the biggest situational awareness enhancer in the F-35 is the radar," that the JSF's HMD enhances situational awareness, and that "the ability to have a contact on the radar and then be able to look out the cockpit and have that contact appear on my visor is as different as day and night from Harrier operations."[28]

An Australian perspective on the JSF is provided by Air Vice Marshal Leigh Gordon who notes:

> The thing that makes the F-35 fifth generation firstly is its stealth. It has been designed as a stealthy aircraft with low reflective surfaces, engines hidden from view. … The second thing, it has some fantastic sensors, quite a leading-edge radar, the DAS cameras—the distributed aperture system cameras—which give you a 360-degree view of the world out to a huge distance.
>
> The third thing is the way all those sensors are fused together to inform the pilot. The fourth thing is the ability to transfer data to other F-35s and indeed other aircraft. That combination of characteristics is not in any other aircraft in service. The F-35 is a multi-role plane that is more appropriate for Australia's needs than any other.[29]

Royal Norwegian Air Force (RNOAF) pilot Major Morten "Dolby" Hanche became the first Norwegian pilot to fly the JSF on November 10, 2015, and has over 2200F-16 flying hours. Hanche described his assessment of the JSF in these comments on Kampflyboggen (The Combat Aircraft Blog) of Norway's JSF program.

> The F-35 provides me as a pilot greater authority to point the nose of the airplane where I desire. (The F-35 is capable of significantly higher Angle of Attack (AOA) than the F-16. Angle of Attack describes the angle between the longitudinal axis of the plane—where nose is pointing—and where the aircraft is actually heading—the vector). This improved ability to point to at my opponent enables me to deliver weapons earlier than I am used to with the F-16, it forces my opponent to react even more defensively, and it gives me the ability to reduce the airspeed quicker than the F-16.[30]

Hanche goes on to make the following positive assertions about JSF performance capabilities:

> It may be difficult to understand why a fighter should be able to "brake" quickly. In the offensive role, this becomes important whenever I point my nose at an opponent who turns towards me. This results in a rapidly decreasing distance between our two airplanes. Being able to slow down quicker provides me the opportunity to maintain my nose pointed towards my opponent longer, thus allowing more opportunities to employ weapons, before the distance decreases so much that a role reversal takes place. To sum it up, my experience so far is that the F-35 makes it easier for me to maintain the offensive role, and it proves me more opportunities to effectively employ weapons at my opponent.
>
> In the defensive role the same characteristics are valuable. I can "whip" the airplane around in a reactive manner while slowing down. The F-35 can actually slow down quicker than you'd be able to emergency brake in your car. This is important because my opponent has to react to me "stopping," or risk ending up in a role-reversal where he flies past me.[31]

There is no doubt the JSF has experienced managerial incompetence, cost overruns, and produced protracted delays testing the patience of the US and allied militaries, their civilian policymakers, and contractors beyond the breaking point. Such problems are not uncommon in the historical development of many weapons systems. The US JSF Program office has had 11 different program directors in its 24-year history! Tangible and sustained progress in the US JSF program finally began occurring during the leadership of Lieutenant General Chris Bogdan. One assessment of Bogdan contends that his tenure has brought energy, honesty, and the quality of leadership the program has needed for years. While this leadership has not been devoid of controversy, it has brought the JSF to Initial Operating Capability for the United States and many other countries. The Trump Administration's recent intervention to lower JSF program costs also gives the program the chance to be successfully implemented if Lockheed Martin and US and allied militaries stick to the current production schedule and reduce costs.[32]

Combat effectiveness and performance of the JSF is the bottom line indicator of whether the expenditure and delays have been worthwhile. Israel's May 2018 use of the JSF against Iranian and Hezbollah targets near Beirut, Lebanon, received positive assessment from the IAF and Lockheed Martin. It remains to be seen if the JSF will perform effectively in the aforementioned combat scenarios. However, it is highly unlikely that existing aging US and allied combat air fleets will be able to consistently and effectively perform against emerging Chinese and Russian jet fighters such as the J-20, J-31, Su-35, and PAK-50 and the air defense, cyberwar, and space capabilities these countries have in the years to come without substantial upgrades in allied combat jet fighter capabilities and other military spectrum assets.[33]

These endeavors also require the United States to make its domestic science and technology enterprise more agile, synchronized, and globally engaged to address emerging threats to military security along with the erosion of US national security supremacy due to the global proliferation of scientific and technological expertise. Such developments give the Trump Administration the opportunity to change such trends by reinventing the relationship between the federal government, the DOD, and other national and homeland security agencies and developing a new paradigm for maintaining its technological security in coming decades.[34]

Not having access to classified information makes such an assessment inherently risky, but technological obsolescence of combat aircraft against military enemies is even more dangerous than an expensive and long-delayed military weapons system. Relying on the goodwill of enemies and placing excessive trust in aging jet fighter technology to resolve military problems are fatally flawed faith-based endeavors which should not be part of the national security strategy of the United States and its allies. The JSF will need to be built and maintained with conventional and nuclear payloads, even at a reduced scale, by the United States and its allies to ensure their ability to credibly back up the Asia-Pacific Pivot, European Deterrence Initiative, deter Russia's pivot to the East, and maintain air superiority in future military confrontations which US and allied statecraft and innate military strength may be unable to avoid if hostile nations and transnational groups are determined to militarily challenge US geopolitical and strategic interests.[35]

Notes

1. Mark Parillo, "A Century of Airpower," in *The Influence of Airpower Upon History: Statesmanship, Diplomacy, and Foreign Policy Since 1903*, Robin Higham and Mark Parillo, eds. (Lexington: University Press of Kentucky, 2013): 279.
2. U.S. Government Accountability Office, *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency* (Washington, DC: GAO, 2017): 6; https://www.gao.gov/assets/690/687982.pdf; accessed January 5, 2018.

3. See U.S. Government Accountability Office, *F-35 Joint Strike Fighter: DOD Needs to Complete Developmental Testing Before Making Significant New Investments* (Washington, DC: GAO, 2017): 1, 5–6; https://www.gao.gov/assets/690/684207.pdf; accessed January 5, 2018; and Stephen G. Brooks, *Producing Security: Multinational Corporations, Globalization, and the Changing Calculus of Conflict* (Princeton: Princeton University Press, 2005): 161–162.
4. Usaspending.gov (Washington, DC, 2018); https://www.usaspending.gov/Pages/AdvancedSearch.aspx?k=joint%20strike%20fighter; accessed January 5, 2018.
5. See Mark A. Lorell and Hugh P. Leveaux, *The Cutting Edge: A Half Century of U.S. Fighter Aircraft R&D* (Santa Monica, CA: Rand Corporation, 1998): 149–153; http://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR939.pdf; accessed January 5, 2018; Anthony L. Velocci, Jr., "Further Consolidation Looms Over Industry: Many More Mergers and Acquisitions Will Occur Including One or Two 'Elephant Deals' Worldwide, *Aviation Week and Space Technology*, 152 (19) (May 8, 2000): 22–24; Judy B. Davis, "The Impact of Defense Industry Consolidation on the Aerospace Industry," Thesis (Wright-Patterson, AFB: Air Force Institute of Technology, 2006); http://handle.dtic.mil/100.2/ADA449606; accessed January 5, 2018; and U.S. Congress, Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operation, Safety, and Security, *The Global Competitiveness of the U.S. Aviation Industry: Addressing Issues to Maintain U.S. Leadership in the Aerospace Market* (Washington, DC: GPO, 2014): http://purl.fdlp.gov/GPO/gpo46733; accessed January 5, 2018.
6. Mac Thornberry and Andrew F. Krepinevich, Jr., "Preserving Primacy: A Defense Strategy for the New Administration," *Foreign Affairs*, 96 (5) (September/October 2016): 31.
7. See Lockheed Martin, "Economic Impact: Powering Job Creation for America and its Allies" (Fort Worth: Lockheed-Martin, 2017): 1; https://www.f35.com/about/economic-impact; accessed January 5, 2018., Ibid., "Global Participation: The Centerpiece of 21st Century Global Security" (Fort Worth: Lockheed-Martin, 2015): 1–2; https://www.f35.com/global; accessed January 5, 2018; David King, "The American Aircraft Industrial Base: On the Brink," *Air and Space Power Journal*, 20 (1) (Spring 2006): 35–44; http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-20_Issue-1-4/2006_Vol20_No1.pdf; accessed January 5, 2018; *The Global Arms Trade: A Handbook*, Andrew T.H. Tan, ed. (London: Routledge, 2015); Australia, Department of Defence, "Australian Industry Building Global Joint Strike Fighter Capability"

(Canberra: Defence Material Organisation, March 20, 2015): 1; http://www.defence.gov.au/dmo/NewsMedia/News/AustralianindustrybuildingglobalJointStrikeFightercapability; accessed January 5, 2018; Industry Canada, *Canadian Industrial Participation in the F-35 Joint Strike Fighter Program Report by Industry Canada* (Ottawa: Industry Canada, 2014); https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Fall_2014_Report_Parliament.pdf/$file/Fall_2014_Report_Parliament.pdf; accessed January 5, 2018; and Great Britain, Ministry of Defence, *Guidance: About Lightning II* (London: MOD, 2015): 1–2; https://www.gov.uk/government/publications/lightning-ii-what-you-need-to-know/about-lightning-ii; accessed January 5, 2018.

8. John A. Alic, “Managing US Defense Acquisition,” *Enterprise & Society*, 14 (1) (March 2013): 31; https://doi.org/10.1093/es/khs051.
9. See Ellen Nakashima, “Key U.S. Weapon Designs Hacked,” *Washington Post* (May 28, 2013): A01; Dave Majumdar, “Russia’s Lethal Su-35 Fighter vs. America’s F-35, F-15, and F-16: Who Wins?,” *The National Interest* (September 19, 2016): 1–4; http://nationalinterest.org/blog/the-buzz/russias-lethal-su-35-fighter-vs-americas-f-35-f-15-f-16-who-17753; accessed March 20, 2017.
10. Eleni Ekmektsioglu, “Hypersonic Weapons and Escalation Control in East Asia,” *Strategic Studies Quarterly*, 9 (2) (Summer 2015): 62; http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-09_Issue-2/ekmektsioglou.pdf; accessed March 20, 2017; and John A. Shaud, *Air Force Strategy Study 2020–2030* (Maxwell AFB, AL: Air University Press, 2011): 100, 105; http://www.dtic.mil/dtic/tr/fulltext/u2/a540345.pdf; accessed March 20, 2017.
11. See Janusz Bugajski, *Dismantling the West: Russia’s Atlantic Agenda* (Washington, DC: Potomac Books, Inc., 2009); Shaud, 92; Luis Simón, “NATO’s Rebirth: Assessing NATO’s Eastern European ‘Flank’”, *Parameters*, 44 (3) (Autumn 2014): 67–79; http://www.strategicstudiesinstitute.army.mil/pubs/Parameters/issues/Autumn_2014/10_SimonLuis_Addressing%20NATO’s%20Eastern%20European%20Flank.pdf; March 20, 2017; U.S. Congress, House Committee on Armed Services, *Russian Military Developments and Strategic Implications* (Washington, DC: GPO, 2015); http://purl.fdlp.gov/GPO/gpo54841; accessed March 20, 2017; Timothy L. Thomas, *Russia Military Strategy: Impacting 21st Century Reform and Geopolitics* (Fort Leavenworth, KS: Foreign Military Studies Office, 2015): 179–190; https://community.apan.org/wg/tradoc-g2/fmso/m/fmso-books/195605; accessed January 5, 2018; Sergey Sevastyanov and Alexey Kravchuk, “The Russian Approach to National Security in the Arctic,” *The Korean Journal of Defense Analysis*, 29 (1) (March 2017): 131–149; and “The Other Pivot: Banyan” *The Economist*, 421 (9017) (November 26, 2016): 53.

12. Vipin Narang, "Nuclear Strategies of Emerging Nuclear Powers: North Korea and Iran," *Washington Quarterly*, 38 (1, 2015): 73–91; https://doi.org/10.1080/0163660X.2015.1038175; U.S. Congress, House Committee on Armed Services, Subcommittee on Seapower and Projection Forces, *The Role of Maritime and Air Power in DOD's Third Offset Strategy* (Washington, DC: GPO, 2015): 10–11; http://purl.fdlp.gov/GPO/gpo58009; accessed March 20, 2017; and Dian Matteo, "The Pivot to Asia, Air-Sea Battle and Contested Commons in the Asia-Pacific Region," *The Pacific Review*, 28 (2) (2015): 237–257; https://doi.org/10.1080/09512748.2014.995124.
13. See *The Dynamics of Military Revolution 1300–2050*, MacGregor Knox and Williamson Murray, eds. (New York: Cambridge University Press, 2001); *The Sources of Military Change: Culture, Politics, and Technology*, Theo Farrell and Terry Terriff, eds. (Boulder: Lynne Rienner Publishers, 2002); Williamson Murray, *Military Adaptation in War With Fear of Change:* (New York: Cambridge University Press, 2011); Burak Kadercan, "Strong Armies, Slow Adaptation: Civil-Military Relations and the Diffusion of Military Power," *International Security*, 38 (3) (Winter 2013/14): 117–152; https://doi.org/10.1162/ISEC_a_00146; *International Military Operations in the 21st Century: Global Trends and the Future of Intervention*, Per M. Norheim-Martinsen and Tore Nyhamer, eds. (London: Routledge, 2015); and U.S. Congress, House Committee on Armed Services, Subcommittee on Oversight and Investigations, *Oversight of the European Reassurance Initiative* (Washington, DC: GPO, 2017): 1–2; http://purl.fdlp.gov/GPO/gpo78477; accessed March 20, 2017; and Rowan Callick, "Taking Up Arms," *The Australian* (March 8, 2017): 11.
14. See Rebecca Grant, *U.S. Air Dominance in a Fiscally-Constrained Environment: Tactical Aircraft and the Preservation of U.S. Air Dominance* (Arlington, VA: Lexington Institute, 2013): http://lexingtoninstitute.org/wp-content/uploads/2013/09/AirDominance.pdf; accessed March 20, 2017; U.S. Congress, Senate Committee on Appropriations, *Department of Defense Appropriations for Fiscal Year 2016* (Washington, DC: GPO, 2015): 1; https://www.gpo.gov/fdsys/pkg/CHRG-114shrg59104640/pdf/CHRG-114shrg59104640.pdf; accessed March 20, 2017, 2015; U.S. Navy, Chief of Naval Operations, *Statement of Admiral Jonathan Greenert on FY 2016 Department of the Navy Posture* (Washington, DC: Department of the Navy, March 4, 2015): http://www.navy.mil/cno/docs/CNO_SACD.pdf; accessed March 20, 2017; *2017 Index of U.S. Military Strength: Assessing America's Ability to Provide for the Common Defense*, Dakota L. Wood, ed. (Washington, DC: The Heritage Foundation, 2016): 378, 380, 388; http://ims-2017.s3.ama-

zonaws.com/2017_Index_of_Military_Strength_WEB.pdf; accessed January 5, 2018; and Andrew F. Krepinevich and Barry D. Watts, *The Last Warrior: Andrew Marshall and the Shaping of Modern American Defense Strategy* (New York: Basic Books, 2015).

15. See Pat Host, "DARPA Studying 'Air Dominance Initiative," *Defense Daily*, 258 (37) (May 20, 2013): 3; U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Hearing on National Defense Authorization for Fiscal Year 2015 and Oversight of Previously Authorized Programs: Fiscal Year 2015 Navy, Marine Corps, and Air Force Combat Aviation Programs* (Washington, DC: GPO, 2014): 23; http://purl.fdlp.gov/GPO/gpo54214; accessed June 29, 2017; Kelsey D. Atherton, "Get Ready for the Next Generation Fighter Jet: The Pentagon Imagines a Post-F35 Future," *Popular Science* (January 29, 2015): 1–4; http://www.popsci.com/pentagon-budgets-next-fighter-generation-0; accessed June 29, 2017; and U.S. Defense Science Board, *DSB Task Force Report on Air Dominance* (Washington, DC: Defense Science Board, 2016); https://www.acq.osd.mil/dsb/reports/2010s/DSB_ExecSumm_AirDominance.pdf; accessed January 5, 2018.
16. See Eugene Gholz and Harvey M. Sapolsky, "Restructuring the U.S. Defense Industry," *International Security*, 24 (3) (Winter 1999/2000): 5–51; Public Law 111–23, "Weapons Systems Acquisition Reform Act of 2009," 123 *U.S. Statutes at Large* 1703–1733; https://www.govinfo.gov/content/pkg/PLAW-111publ23/pdf/PLAW-111publ23.pdf; accessed March 20, 2017; Mark A. Lorell, Michael Kennedy, Robert S. Leonard, et al., *Do Joint Strike Fighter Programs Save Money?* (Santa Monica, CA: Rand Corporation, 2013): xii-xix; http://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1225/RAND_MG1225.sum.pdf; accessed March 22, 2017; and U.S. Government Accountability Office, *Defense Contracting: Early Attention in the Acquisition Process Needed to Enhance Competition* (Washington, DC: GAO, 2014); http://www.gao.gov/assets/680/678888.pdf; accessed March 22, 2017.
17. Kenneth Anderson, "The Case for Drones," *Commentary*, 135 (6) (June 2013): 14–23.
18. See Andrew Herr, "Will Humans Matter in the Wars of 2030?," *Joint Force Quarterly*, 77 (2nd Quarter 2015): 78; http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-77/jfq-77_76-83_Herr.pdf; accessed March 22, 2017; and Michael J. Boyle, "The Race for Drones," *Orbis*, 59 (1) (Winter 2015): 76–94; https://doi.org/10.1016/j.orbis.2014.11.007.
19. Herr, 81.
20. See Ibid., and Jeremy T. Nelson, et al., "Enhancing Vigilance in Operators With Prefrontal Cortex Transcranial Stimulation (tDCS)," *NeuroImage*,

85 (3) (January 15, 2014): 909–917; https://doi.org/10.1016/j.neuroimage.2012.11.061.

21. U.S. Congress, Senate Committee on Armed Services, *The Future of Warfare* (Washington, DC: GPO, 2016): 37, 51; http://purl.fdlp.gov/GPO/gpo66992; accessed March 20, 2017.
22. See Australia, Parliament, Senate Committee on Foreign Affairs, Defence, and Trade, *Submissions Received by the Committee: Mr. Chris Mills*, http://www.aph.gov.au/DocumentStore.ashx?id=cb696c8f-26b1-494c-ab8e-0555ef0fd7b4&subId=407251; 5–7; accessed March 20, 2017; and the simulations referred to in this submission are accessible at https://www.youtube.com/watch?v=Z-wP8OEm8F0; and https://www.youtube.com/watch?v=DX9e2zti_us; accessed January 5, 2018.
23. John Venable, *Operational Assessment of the F-35A Argues for Full Program Procurement and Concurrent Development Process* (Washington, DC: The Heritage Foundation, August 4, 2016): 9; http://thf-reports.s3.amazonaws.com/2016/BG3140.pdf; accessed January 5, 2018.
24. See Ibid., 10; and U.S. Naval Air Training Command, *Flight Training Instruction: Basic Fighter Maneuvering Section Engaged Maneuvering T-45* (Corpus Christ: NAS Corpus Christi, 2016): 5–27; https://www.cnatra.navy.mil/local/docs/pat-pubs/P-1289.pdf; accessed June 14, 2018.
25. Venable, 4–5.
26. Kris Osborne, "US Air Force Pilot: The F-35 Stealth Fighter is the World's Best," *The National Interest* (June 29, 2016): 2; http://nationalinterest.org/blog/the-buzz/us-air-force-pilot-the-f-35-stealth-fighter-the-worlds-best-16790; accessed March 21, 2017.
27. See David Majumdar, *The National Interest* (September 19, 2016): 1–3; http://nationalinterest.org/print/blog/the-buzz/russias-lethal-su-35-fighter-vs-americas-f-35-f-15-f-16-who-17753; accessed March 21, 2017; and Ibid., "Wargame Shows Lockheed Martin F-35 Joint Strike Fighter Kills 15 Fighters for Every Loss," *The National Interest* (February 7, 2017): 1–3; http://nationalinterest.org/blog/the-buzz/wargame-shows-lockheed-martin-f-35-joint-strike-fighter-19352; accessed March 21, 2017.
28. Guy Norris, "Pilot Reaction to Flying the F-35B," *Aviation Week Blog* (April 24, 2014): 2–3; http://aviationweek.com/blog/pilot-reaction-flying-f-35b; accessed January 5, 2018.
29. Paul Cleary, "Delivering the Right Stuff," *The Australian* (March 3, 2017): 13.
30. Morton Hanche, "The F-35 in a Dogfight: What I Have Learned So Far," *Kampflybloggen* (March 1, 2016): 10; https://nettsteder.regjeringen.no/kampfly/2016/03/01/f-35-i-naerkamp-hva-har-jeg-laert-sa-langt-the-f-35-in-a-dogfight-what-have-i-learned-so-far/; accessed January 5, 2018.

31. Ibid., 11.
32. See Venable, 11, Amy Butler, "Frank, Feared, and Respected," *Aviation Week and Space Technology*, 175 (1) (January 14, 2013): 48; William T. Eliason, "An Interview With Christopher C. Bogdan," *Joint Force Quarterly*, 78 (July 2015): 54–60; http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-78/jfq-78_54-60_Bogdan.pdf; accessed March 21, 2017; Jon Harper, "F-35 in Trump Administration's Crosshairs," *National Defense* (February 2017): 8; Eliot V. Converse III, *History of Acquisition in the Department of Defense: Volume I: Rearming for the Cold War, 1945–1960* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2012): http://purl.fdlp.gov/GPO/gpo23378; accessed August 16, 2018; Walter S. Poole, *History of Acquisition in the Department of Defense: Volume II: Adapting to Flexible Response, 1960–1968* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2013): http://purl.fdlp.gov/GPO/gpo23378; accessed August 16, 2018; and The F-35 Lightning II, *Leadership* (Washington, DC: Joint Strike Fighter Program Office, 2018): 1; http://www.jsf.mil/leadership/index.htm; accessed January 5, 2018.
33. See Thomas Mahnken, *Technology and the American Way of War* (New York: Columbia University Press, 2008); Colin S. Gray, "Understanding Air Power: Bonfire of the Fallacies," *Strategic Studies Quarterly*, 2 (4) (Winter 2008): 43–83; http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-02_Issue-4/Gray.pdf; March 20, 2017; Colin S. Gray, *Airpower for Strategic Effect* (Maxwell AFB, AL: Air University Press, 2012); http://purl.fdlp.gov/GPO/gpo56522; accessed January 5, 2018; Robert Haddick, *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis, MD: Naval Institute Press, 2014); Mark Clodfelter, "Theory, Implementation, and the Future of Airpower," *Air and Space Power Journal*, 28 (5) (September–October 2014): 118–125; http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-5/V-Clodfelter.pdf; accessed January 5, 2018; Michael Pillsbury, *The Hundred Year Marathon: China's Secret Strategy to Replace America as the Global Superpower* (New York: Henry Holt and Company, 2015); and Anna Ahronheim, "Israel Air Force Commander Maj.-Gen. Amikam Norkin Speaks About Israel's Use of the F-35 (IDF Spokesperson's Unit, Adir Stealth Fighter Jet," *Jerusalem Post* (May 23, 2018): 1–2; https://www.jpost.com/Israel-News/IAF-commander-Israel-first-to-use-F-35-jet-in-combat-558030; accessed May 23, 2018.
34. James Kadtke and John Wharton, *Technology and National Security: The United States at a Critical Crossroads* (Washington, DC: National Defense University Press, 2018): http://ndupress.ndu.edu/Portals/68/Documents/defensehorizon/DH-84.pdf; accessed June 14, 2018.
35. Sevastyanov and Kravchuk.

References

Ahronheim, Anna. "Israel Air Force Commander Maj.-Gen Amikam Norkin Speaks Ab out Israel's Use of the F-35 (IDF Spokesperson's Unit) Adir Stealth Fighter Jet." *Jerusalem Post* (May 23, 2018): 1–2. https://www.jpost.com/Israel-News/IAF-commander-Israel-first-to-use-F-35-jet-in-combat-558030. Accessed May 23, 2018.

Alic, John A. "Managing US Defense Acquisition." *Enterprise & Society*, 14 (1) (March 2013): 31. https://doi.org/10.1093/es/khs051.

Anderson, Kenneth. "The Case for Drones." *Commentary*, 135 (6) (June 2013): 14–23.

Atherton, Kelsey D. "Get Ready for the Next Generation Fighter Jet: The Pentagon Imagines a Post-F35 Future." *Popular Science* (January 29, 2015): 1–4. http://www.popsci.com/pentagon-budgets-next-fighter-generation-0. Accessed June 29, 2017.

Australia. Department of Defence. *Australian Industry Building Global Joint Strike Fighter Capability* (Canberra: Defence Material Organization, March 20, 2015): 1. http://www.defence.gov.au/dmo/NewsMedia/News/AustralianindustrybuildingglobalJointStrikeFightercapability. Accessed January 5, 2018.

Australia. Parliament. Senate Committee on Foreign Affairs, Defence, and Trade. *Submissions Received by the Committee: Mr. Chris Mills.* http://www.aph.gov.au/DocumentStore.ashx?id=cb696c8f-26b1-494c-ab8e-0555ef0fd7b4&subId=407251; 5–7. Accessed March 20, 2017; and the simulations referred to in this submission are accessible at https://www.youtube.com/watch?v=Z-wP8OEm8F0. https://www.youtube.com/watch?v=DX9e2zti_us. Accessed January 5, 2018.

Boyle, Michael J. "The Race for Drones." *Orbis*, 59 (1) (Winter 2015): 76–94. https://doi.org/10.1016/j.orbis.2014.11.007.

Brooks, Stephen G. *Producing Security: Multinational Corporations, Globalization, and the Changing Calculus of Conflict* (Princeton: Princeton University Press, 2005): 161–162.

Bugajski, Janusz. *Dismantling the West: Russia's Atlantic Agenda* (Washington, DC: Potomac Books, Inc., 2009).

Butler, Amy. "Frank, Feared, and Respected." *Aviation Week and Space Technology*, 175 (1) (January 14, 2013): 48.

Callick, Rowan. "Taking Up Arms." *The Australian* (March 8, 2017): 11.

Cleary, Paul. "Delivering the Right Stuff." *The Australian* (March 3, 2017): 13.

Clodfelter, Mark. "Theory, Implementation, and the Future of Air Power." *Air and Space Power Journal*, 28 (5) (September–October 2014): 118–125. http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-5/V-Clodfelter.pdf. Accessed January 5, 2018.

Converse III, Eliot V. *History of Acquisition in the Department of Defense: Volume I: Rearming for the Cold War, 1945–1960* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2012). http://purl.fdlp.gov/GPO/gpo23378. Accessed August 16, 2018.

Davis, Judy B. "The Impact of Defense Industry Consolidation on the Aerospace Industry." Thesis (Wright-Patterson, AFB: Air Force Institute of Technology, 2006). http://handle.dtic.mil/100.2/ADA449606. Accessed January 5, 2018.

Ekmektsioglu, Eleni. "Hypersonic Weapons and Escalation Control in East Asia." *Strategic Studies Quarterly*, 9 (2) (Summer 2015): 62. http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-09_Issue-2/ekmektsioglou.pdf. Accessed March 20, 2017.

Eliason, William T. "An Interview With Christopher C. Bogdan." *Joint Force Quarterly*, 78 (July 2015): 54–60. http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-78/jfq-78_54-60_Bogdan.pdf. Accessed March 21, 2017.

F-35 Lightning II. *Leadership* (Washington, DC: Joint Strike Fighter Program Office, 2018): 1. http://www.jsf.mil/leadership/index.htm. Accessed January 5, 2018.

Farrell, Theo, and Terry Terriff, eds. *Sources of Military Change: Culture, Politics, and Technology* (Boulder: Lynne Rienner Publishers, 2002).

Gholz, Eugene, and Harvey M. Sapolsky. "Restructuring the U.S. Defense Industry." *International Security*, 24 (3) (Winter 1999/2000): 5–51.

Grant, Rebecca. *U.S. Air Dominance in a Fiscally-Constrained Environment: Tactical Aircraft and the Preservation of U.S. Air Dominance* (Arlington, VA: Lexington Institute, 2013). http://lexingtoninstitute.org/wp-content/uploads/2013/09/AirDominance.pdf. Accessed March 20, 2017.

Gray, Colin S. "Understanding Air Power: Bonfire of the Fallacies." *Strategic Studies Quarterly*, 2 (4) (Winter 2008): 43–83. http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-02_Issue-4/Gray.pdf. Accessed March 20, 2017.

———. *Airpower for Strategic Effect* (Maxwell AFB, AL: Air University Press, 2012). http://purl.fdlp.gov/GPO/gpo56522. Accessed January 5, 2018.

Great Britain. Ministry of Defence. *Guidance: About Lightning II* (London: MOD, 2015): 1–2. https://www.gov.uk/government/publications/lightning-ii-what-you-need-to-know/about-lightning-ii. Accessed January 5, 2018.

Haddick, Robert. *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis, MD: Naval Institute Press, 2014).

Hanche, Morton. "The F-35 in a Dogfight: What I Have Learned So Far." *Kampflybloggen* (March 1, 2016): 10. https://nettsteder.regjeringen.no/kampfly/2016/03/01/f-35-i-naerkamp-hva-har-jeg-laert-sa-langt-the-f-35-in-a-dogfight-what-have-i-learned-so-far/. Accessed January 5, 2018.

Harper, Jon. "F-35 in Trump Administration's Crosshairs." *National Defense* (February 2017): 8.
Herr, Andrew. "Will Humans Matter in the Wars of 2030?" *Joint Force Quarterly*, 77 (2nd Quarter 2015): 78. http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-77/jfq-77_76-83_Herr.pdf. Accessed March 22, 2017.
Host, Pat. "DARPA Studying 'Air Dominance Initiative" *Defense Daily*, 258 (37) (May 20, 2013): 3.
Industry Canada. *Canadian Industrial Participation in the F-35 Joint Strike Fighter Program* (Ottawa: Industry Canada, 2014). https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Fall_2014_Report_Parliament.pdf/$file/Fall_2014_Report_Parliament.pdf. Accessed January 5, 2018.
Kadercan, Burak. "Strong Armies, Slow Adaptation: Civil-Military Relations and the Diffusion of Military Power." *International Security*, 38 (3) (Winter 2013/14): 117–152. https://doi.org/10.1162/ISEC_a_00146.
Kadtke, James, and John Wharton. *Technology and National Security: The United States at a Critical Crossroads* (Washington, DC: National Defense University Press, 2018). http://ndupress.ndu.edu/Portals/68/Documents/defensehorizon/DH-84.pdf. Accessed June 14, 2018.
King, David. "The American Aircraft Industrial Base: On the Brink." *Air and Space Power Journal*, 20 (1) (Spring 2006): 35–44. http://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-20_Issue-1-4/2006_Vol20_No1.pdf. Accessed June 5, 2018.
Knox, MacGregor, and Williamson Murray, eds. *The Dynamics of Military Revolution 1300–2050* (New York: Cambridge University Press, 2001).
Krepinevich, Andrew F., and Barry D. Watts. *The Last Warrior: Andrew Marshall and the Shaping of Modern American Defense Strategy* (New York: Basic Books, 2015).
Lockheed Martin. *Economic Impact: Powering Job Creation for America and Its Allies* (Fort Worth: Lockheed-Martin, 2017a): 1. https://www.f35.com/about/economic-impact. Accessed January 5, 2018.
———. *Global Participation: The Centerpiece of 21st Century Global Security* (Fort Worth: Lockheed Martin, 2017b): 1–2. https://www.f35.com/global. Accessed January 5, 2018.
Lorell, Mark A., and Hugh P. Leveaux. *The Cutting Edge: A Half Century of U.S. Fighter Aircraft R&D* (Santa Monica, CA: Rand Corporation, 1998): 149–153. http://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR939.pdf. Accessed January 5, 2018.
Lorell, Mark A., Michael Kennedy, Robert S. Leonard, et al. *Do Joint Strike Fighter Programs Save Money?* (Santa Monica, CA: Rand Corporation, 2013): xii–xix. http://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1225/RAND_MG1225.sum.pdf. Accessed March 22, 2017.

Mahnken, Thomas. *Technology and the American Way of War* (New York: Columbia University Press, 2008).
Majumdar, Dave. "Russia's Lethal Su-35 Fighter vs. America's F-35, F-15, and F-16: Who Wins?" *The National Interest* (September 19, 2016): 1–4. http://nationalinterest.org/blog/the-buzz/russias-lethal-su-35-fighter-vs-americas-f-35-f-15-f-16-who-17753. Accessed March 20, 2017.
———. "Wargame Shows Lockheed Martin F-35 Joint Strike Fighter Kills 15 Fighters for Every Loss." *The National Interest* (February 7, 2017): 1–3. http://nationalinterest.org/blog/the-buzz/wargame-shows-lockheed-martin-f-35-joint-strike-fighter-19352. Accessed March 21, 2017.
Matteo, Dian. "The Pivot to Asia, Air-Sea Battle and Contested Commons in the Asia-Pacific Region." *The Pacific Review*, 28 (2, 2015): 237–257. https://doi.org/10.1080/09512748.2014.995124.
Murray, Williamson. *Military Adaptation in War with Fear of Change* (New York: Cambridge University Press, 2011).
Nakashima, Ellen. "Key U.S. Weapon Designs Hacked." *Washington Post* (May 28, 2013): A01.
Narang, Vipin. "Nuclear Strategies of Emerging Nuclear Powers: North Korea and Iran." *Washington Quarterly*, 38 (1, 2015): 73–91. https://doi.org/10.1080/0163660X.2015.103817.
Nelson, Jeremy T. et al. "Enhancing Vigilance in Operators With Prefrontal Cortex Transcranial Stimulation (tDCS)." *NeuroImage*, 85 (3) (January 15, 2014): 909–917. https://doi.org/10.1016/j.neuroimage.2012.11.061.
Norheim Martinsen, Per M., and Tore Nyhamer, eds. *International Military Operations in the 21st Century: Global Trends and the Future of Intervention* (London: Routledge, 2015).
Norris, Guy. "Pilot Reaction to Flying the F-35B." *Aviation Week Blog* (April 24, 2014): 2–3. http://aviationweek.com/blog/pilot-reaction-flying-f-35b. Accessed January 5, 2018.
Osborne, Kris. "US Air Force Pilot: The F-35 Stealth Fighter is the World's Best." *The National Interest* (June 29, 2016): 2. http://nationalinterest.org/blog/the-buzz/us-air-force-pilot-the-f-35-stealth-fighter-the-worlds-best-16790. Accessed March 21, 2017.
Parillo, Mark. "A Century of Airpower." In *The Influence of Airpower Upon History: Statesmanship, Diplomacy, and Foreign Policy Since 1903*, ed. Robin Higham and Mark Parillo (Lexington: University Press of Kentucky, 2013).
Pillsbury, Michael. *The Hundred Year Marathon: China's Secret Strategy to Replace America as the Global Superpower* (New York: Henry Holt and Company, 2015).
Poole, Walter S. *History of Acquisition in the Department of Defense: Volume 2: Adapting to Flexible Response, 1960–1968* (Washington, DC: Historical Office,

Office of the Secretary of Defense, 2013). http://purl.fdlp.gov/GPO/gpo23378. Accessed August 16, 2018.

Public Law 111-23. "Weapons Systems Acquisition Reform Act of 2009." 123 *U.S. Statutes at Large* 1703–1733. https://www.govinfo.gov/content/pkg/PLAW-111publ23/pdf/PLAW-111publ23.pdf. Accessed March 20, 2017.

Sevastyanov, Sergei, and Alexey Kravchuk. "The Russian Approach to National Security in the Arctic." *The Korean Journal of Defense Analysis*, 29 (1) (March 2017): 131–149.

Shaud, John A. *Air Force Strategy Study 2020–2030* (Maxwell AFB, AL: Air University Press, 2011): 100. http://www.dtic.mil/dtic/tr/fulltext/u2/a540345.pdf. Accessed March 20, 2017.

Simón, Luis. "NATO's Rebirth: Assessing NATO's Eastern European 'Flank'". *Parameters*, 44 (3) (Autumn 2014): 67–79. http://www.strategicstudiesinstitute.army.mil/pubs/Parameters/issues/Autumn_2014/10_SimonLuis_Addressing NATO's Eastern European Flank.pdf. Accessed March 20, 2017.

Tan, Andrew T.H., ed. *The Global Arms Trade: A Handbook* (London: Routledge, 2015).

"The Other Pivot: Banyan." *The Economist*, 4021 (9017) (November 26, 2016): 53.

Thomas, Timothy L. *Russia Military Strategy: Impacting 21st Century Reform and Geopolitics* (Fort Leavenworth, LS: Foreign Military Studies Office, 2015): 179–190. https://community.apan.org/wg/tradoc-g2/fmso/m/fmso-books/195605. Accessed January 5, 2018.

Thornberry, Mac, and Andrew F. Krepinevich, Jr. "Preserving Primacy: A Defense Strategy for the New Administration." *Foreign Affairs*, 96 (5) (September/October 2016): 31.

U.S. Congress. Senate Committee on Commerce, Science, and Transportation. Subcommittee on Aviation Operation, Safety, and Security. *The Global Competitiveness of the U.S. Aviation Industry: Addressing Issues to Maintain U.S. Leadership in the Aerospace Market* (Washington, DC: GPO, 2014). http://purl.fdlp.gov/GPO/gpo46733. Accessed January 5, 2018.

———. House Committee on Armed Services. *Russian Military Developments and Strategic Implications* (Washington, DC: GPO, 2015a). http://purl.fdlp.gov/GPO/gpo54841. Accessed March 20, 2017.

———. Senate Committee on Appropriations. *Department of Defense Appropriations for Fiscal Year 2016* (Washington, DC: GPO, 2015b): 1. https://www.gpo.gov/fdsys/pkg/CHRG-114shrg59104640/pdf/CHRG-114shrg59104640.pdf. Accessed March 20, 2017.

———. Senate Committee on Armed Services. *The Future of Warfare* (Washington, DC: GPO, 2016): 37, 51. http://purl.fdlp.gov/GPO/gpo66992. Accessed March 20, 2017.

U.S. Congress. House Committee on Armed Services. Subcommittee on Tactical Air and Land Forces. *Hearing on National Defense Authorization for Fiscal Year 2015 and Oversight of Previously Authorized Programs: Fiscal Year 2015 Navy, Marine Corps, and Air Force Combat Aviation Programs* (Washington, DC: GPO, 2014): 23. http://purl.fdlp.gov/GPO/gpo54214. Accessed June 29, 2017.

———. Subcommittee on Seapower and Projection Forces. *The Role of Maritime and Air Power in DOD's Third Offset Strategy* (Washington, DC: GPO, 2015): 10–11. http://purl.fdlp.gov/GPO/gpo58009. Accessed March 20, 2017.

———. Subcommittee on Oversight and Investigations. *Oversight of the European Reassurance Initiative* (Washington, DC: GPO, 2017): 1–2. http://purl.fdlp.gov/GPO/gpo78477. Accessed March 20, 2017.

U.S. Defense Science Board. *DSB Task Force Report on Air Dominance* (Washington, DC: Defense Science Board, 2016). https://www.acq.osd.mil/dsb/reports/2010s/DSB_ExecSumm_AirDominance.pdf. Accessed January 5, 2018.

U.S. Government Accountability Office. *Defense Contracting: Early Attention in the Acquisition Process Needed to Enhance Competition* (Washington, DC: GAO, 2014). http://www.gao.gov/assets/680/678888.pdf. Accessed March 22, 2017.

———. *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency* (Washington, DC: GAO, 2017a): 6. https://www.gao.gov/assets/690/687982.pdf. Accessed January 5, 2018.

———. *F-35 Joint Strike Fighter: DOD Needs to Complete Developmental Testing Before Making Significant New Investments* (Washington, DC: GAO, 2017b): 1, 5. https://www.gao.gov/assets/690/684207.pdf. Accessed January 5, 2018.

U.S. Naval Air Training Command. *Flight Training Instruction: Basic Fighter Maneuvering Section Engaged Maneuvering T-45* (Corpus Christ: NAS Corpus Christi, 2016): 5–27. https://www.cnatra.navy.mil/local/docs/pat-pubs/P-1289.pdf. Accessed June 14, 2018.

U.S. Navy. Chief of Naval Operations. *Statement of Jonathan Greenert on the FY 2016 Department of the Navy Posture* (Washington, DC: Department of the Navy, March 4, 2015). http://www.navy.mil/cno/docs/CNO_SACD.pdf. Accessed March 20, 2017.

Usaspending.gov (Washington, DC, 2018). https://www.usaspending.gov/Pages/AdvancedSearch.aspx?k=joint%20strike%20fighter. Accessed January 5, 2018.

Velocci, Jr., Anthony L. "Further Consolidation Looms Over Industry: Many More Mergers and Acquisitions Will Occur Including One of Two 'Elephant Deals' Worldwide." *Aviation Week and Space Technology*, 152 (19) (May 8, 2000): 22–24.

Venable, John. *Operational Assessment of the F-35A Argues for Full Program Procurement and Concurrent Development Process* (Washington, DC: The Heritage Foundation, August 4, 2016): 9. http://thf-reports.s3.amazonaws.com/2016/BG3140.pdf. Accessed January 5, 2018.

Wood, Dakota L., ed. *Index of U.S. Military Strength: Assessing America's Ability to Provide for the Common Defense* (Washington, DC: The Heritage Foundation, 2016): 378, 380, 388. http://ims-2017.s3.amazonaws.com/2017_Index_of_Military_Strength_WEB.pdf. Accessed January 5, 2018.

Glossary

A2/AD Anti-Access Aerial Denial
A-6 US Fighter Plane
A-7 US Fighter Plane
A-10 US Fighter Plane
AB Alberta (Canada)
ABL Air Borne Laser
ADF Australian Defence Force
ADIZ Air Defense Identification Zone
ADOD Australian Department of Defence
AECA Arms Export Control Act
AEI American Enterprise Institute (US)
AFB Air Force Base
AG Auditor General (Canada)
AGM Air-to-Ground Missile
AIAC Aerospace Industries Association of Canada
AIDC Aerospace Industrial Development Corporation (Taiwan)
AL Alabama (AL)
ALIS Automatic Logistics Information System
ALP Australian Labour Party
AMRAAM Advanced Medium Range Air-to-Air Missile
ANAO Australian National Audit Office
AOA Angle of Attack
APA Air Power Australia

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7

APUC Average Procurement Unit Cost (US)
AR Arkansas (AR)
ASB Air-Sea Battle (US)
ASM Air-to-Surface Missile
ASPI Australian Strategic Policy Institute
AZ Arizona (US)
B-1 US bomber
BAE Systems British Aerospace Systems
BC British Columbia (Canada)
BUR Bottom-Up Review (US)
BVR Beyond Visual Range
C4ISR Command, Control, Computers, Communications, Intelligence, Surveillance, and Reconnaissance
CA California (US)
CAN Canadian dollar
CBO Congressional Budget Office (US)
CF-18 Hornet Canadian Fighter Plane
CH-47 US helicopter
CNI Communications, Navigation, and Identification
CNO Chief of Naval Operations (US)
CON Conservative Party (UK)
CPC Conservative Party of Canada
CRS Congressional Research Service (US)
CSBA Center for Strategic and Budgetary Assessments (US)
CSIS Center for Strategic and International Studies (US)
CSTO Collective Security Treaty Organization
CT Connecticut (US)
CTOL Conventional Take-Off and Landing
D Democratic Party (US)
DAPA Defense Acquisition Program Administration (South Korea)
DARPA Defense Advanced Research Projects Agency (US)
DAS Distributed Aperture System
Dassault Rafale French Fighter Plane
DCMA Defense Contract Management Agency
Defence Department of Defense (Australia)
DKK Danish Kroners
DMO Defence Material Organisation (Australia)
DMZ Demilitarized Zone (38° of latitude between North and South Korea)

DND Department of National Defence (Canada)
DOD Department of Defense (US)
DODIG Department of Defense Office of Inspector General (US)
DPP Democratic Progressive Party (Taiwan)
DSB Defense Science Board (US)
DSCA Defense Security Cooperation Administration (US)
DSTO Defense Science and Technology Organisation (Australia)
$ Dollar US Currency
EA-6 US electronic warfare plane
EA-18G US and Australian electronic warfare fighter
ECM Electronic countermeasure
EMALS Electromagnetic Aircraft Launch System (UK)
EMD Engineering and manufacturing development
EOTS Electro-Optical Targeting System
ERI European Reassurance Initiative
€ Euro Currency used by many European countries
Eurofighter Typhoon Jet fighter produced by various European countries
EW Electronic Warfare
F-4 US Fighter Plane
F-5 US Fighter Plane
F-15 US Fighter Plane
F-16 US Fighter Plane
F-18 US and Australian Fighter Plane
F-20 US Fighter Plane
F-22 US Fighter Plane
F-84 US Fighter Plane
F-86 US and British Fighter Plane
F-94 US Fighter Plane
F-100 US Fighter Plane
F-101 US and Canadian Fighter Plane
F-102 US Fighter Plane
F-104 US Fighter Plane
F-105 US Fighter Plane
F-106 US Fighter Plane
F-111 US and Australian Fighter Plane
F-117A US Fighter Plane
FACO Final Assembly and Checkout Facility

FBW Fly-by-wire
FCS Future Combat System (US Army)
FL Florida (US)
FMSO Foreign Military Studies Office (US Army)
Folketing Danish Parliament
FY Fiscal Year
GA Georgia (US)
GAO Government Accountability Office (US)
GBU Guided Bomb Unit
GDP Gross Domestic Product
GPS Global Positioning System
Gripen Swedish jet fighter produced by Saab
Harrier GR7 British Fighter Plane
HI Hawaii (US)
HMD Helmet Mounted Display or HMDS (Helmet Mounted Display System)
HMS Her Majesty's Ship (UK)
HM Treasury Her Majesty's Treasury (UK)
HUD Head Up Display
IACP International Armament Cooperative Programs (US)
IADS Integrated Air Defense System
IAI Israel Aerospace Industries
IAF Israel Air Force
IC Industry Canada
ICBM Intercontinental Ballistic Missile
IDF Indigenous Defense Fighter (Taiwan)
IDF Israel Defense Force
IF Internal fuel
IISS International Institute of Strategic Studies (UK)
IL Illinois (US)
IN Indiana (US)
IOC Initial Operating Capability
IRBM Intermediate Range Ballistic Missile
IS Islamic State
ISTAR Intelligence, Surveillance, Target Acquisition, and Reconnaissance
ITAR International Traffic in Arms Regulations (US)
J-6 Chinese Fighter Plane
J-7 Chinese Fighter Plane
J-10 Chinese Fighter Plane

J-11 Chinese Fighter Plane
J-15 Chinese Fighter Plane
J-20 Chinese (Chengdu) Fighter Plane
J-31 Chinese (Shenyang) Fighter Plane
Jaguar-GR 3 British Fighter Plane
JAM-GC Joint Concept for Access and Maneuver in the Global Commons (US)
JAS 39 Gripen Swedish (Saab) Fighter Plane
JASDF Japanese Air Self-Defense Force
JAST Joint Advanced Strike Technology
JDAM Joint Direct Attack Munitions
JFQ Joint Force Quarterly (US military journal)
JSF Joint Strike Fighter
JSM Joint Strike Missile (Norway)
JSOW Joint Stand-Off Weapon
KF-X Proposed South Korean Fighter Plane
KIDA Korea Institute for Defense Analyses
KMT Kuomintang (Taiwanese political party)
Knesset Israeli Parliament
KRW South Korean Won
LAB Labour Party (UK)
LCC Life Cycle Cost
LGB Laser-Guided Bomb
LIB Liberal Party (Canada)
LM Lockheed Martin
LP Liberal Party (Australia)
LTV Ling-Temco-Vought
MA Massachusetts (US)
MADL Multifunction Advanced Data Link
MB Manitoba (Canada)
MCAS Marine Corps Air Station (US)
MD Maryland (US)
MDAP Major Defense Acquisition Programs
ME Maine (US)
MI Michigan (US)
MiG (Mikoyan-Gurevich)-15 Soviet Fighter Plane
MiG-17 Soviet Fighter Plane
MiG-23 Soviet Fighter Plane
MiG-29 Soviet/Russian Fighter Plane
Mirage-III French Fighter Plane

Mirage 2000 French Fighter Plane
MN Minnesota (US)
MO Missouri (US)
MOD Ministry of Defence (UK)
MOU Memorandum of Understanding
MQ-1B Predator US UAV
MQ-9 Reaper US UAV
MRBM Medium-Range Ballistic Missile
MRC Major regional conflict
MRF Multirole Fighter (US)
MRO&U Maintenance, Repair, Overhaul, and Upgrade (Italy)
MS Mississippi (US)
NAC Netherlands Aerospace Centre
NACA National Advisory Committee on Aeronautics (US)
NACC New Air Combat Capability (Australia)
NAF New America Foundation (US)
NAO National Audit Office (UK)
NASIC National Air and Space Intelligence Center (US)
NATO North Atlantic Treaty Organization
NC North Carolina (US)
ND North Dakota (US)
NDP New Democratic Party (Canada)
Netherlands States General Dutch Parliament
NFLD Newfoundland and Labrador (Canada)
NFPS National Fighter Procurement Secretariat (Canada)
NH New Hampshire (US)
NJ New Jersey (US)
NOK Norwegian Kroner
NORAD North American Aerospace Defense Command (US and Canada)
NS Nova Scotia (Canada)
NSW New South Wales (Australia)
NU Nunavut (Canada)
NV Nevada (US)
NWT Northwest Territory (Canada)
NY New York (US)
OH Ohio (US)
OK Oklahoma (US)
ON Ontario (Canada)
OSD Office of the Secretary of Defense (OSD)

£ Pound United Kingdom Currency
P-3C Long-range aircraft (US)
PA Pennsylvania (US)
PAUC Program Acquisition Unit Cost (US)
PBO Parliamentary Budget Officer (Canada)
PBV Post-Boost Vehicle
PCD Panoramic Cockpit Display
PLA People's Liberation Army (China)
PLAAF People's Liberation Army Air Force (China)
PLAN People's Liberation Army Navy (China)
PW Pratt & Whitney
PWGSC Public Works and Government Services Canada
QC Quebec (Canada)
QDR Quadrennial Defense Review (US)
QLD Queensland (Australia)
R Republican Party (US) also GOP
RAF Royal Air Force (UK)
RAAF Royal Australian Air Force
RCAF Royal Canadian Air Force
RCS Radar Cross Section
RDT&E Research, Development, Test, and Evaluation
RFI Request for Information
RI Rhode Island (US)
Rigsrevisionen Denmark's National Auditor
RNAF Royal Netherlands Air Force
RNOAF Royal Norwegian Air Force
RQ-4 Global Hawk—US UAV
RSAF Royal Singapore Air Force
RUSI Royal United Services Institute (UK)
SA South Australia (Australia)
SADI Strategic Aerospace and Defence Initiative (Canada)
SAM Surface-to-Air Missile
SAR Selected Acquisition Report (US)
SC South Carolina (US)
SDD System Development and Demonstration
SDG Singapore Dollar
SDSR Strategic Defence and Security Review (United Kingdom)
SIPRI Stockholm International Peace Research Institute
SLBM Submarine-Launched Ballistic Missile

SNP Scottish National Party
SR-71 US Reconnaissance Plane
SRBM Short-Range Ballistic Missile
Stealth Technology A range of tactics used to make aircraft less visible or invisible to enemy radar. Also called low observable (LO) technology
Storting Norwegian Parliament
STOVL Short Take-Off and Vertical Landing
(Sukhoi) SU-27 Russian/Chinese Fighter Plane
Su-35 Russian and Chinese Fighter Plane
Su-47 Russian Fighter Plane
T-50 PAK FA Russian Fighter Plane
TAI Turkish Aviation Industries
TAIA Taiwan Aerospace Industry Association
TBS Treasury Board Secretariat (Canada)
TFX Tactical Fighter Experiment F-111 Program (US)
TRA Taiwan Relations Act (US 1979)
TX Texas (US)
UAVs Unmanned Aerial Vehicles
UH 1 US helicopter
UNCLOS United Nations Commission on the Law of the Sea
USAF United States Air Force
USMC United States Marine Corps
USN United States Navy
USS United States Ship
UT Utah (US)
X-35 (US)
VA Virginia (US)
VIC Victoria (Australia)
VLO Very Low Observable
VOA Voice of America
V/STOL Vertical/Short Take-Off and Landing
VT Vermont (US)
WA Washington (US)
WA Western Australia (Australia)
WI Wisconsin (US)
WSARA Weapons Systems Acquisition Reform Act (US 2009)
Xianglong/Soar Dragon Chinese UAV
¥ Yen Japanese currency

Index[1]

[1] Note: Page numbers followed by 'n' refer to notes.

B. Chapman, *Global Defense Procurement and the F-35 Joint Strike Fighter*,
https://doi.org/10.1007/978-3-030-01367-7

O