





CHINESE PEOPLE'S LIBERATION ARMY AIR FORCE MODERNIZATION

Major Geneviève Vallières

JCSP 46

Solo Flight

Disclaimer

Opinions expressed remain those of the author and do not represent Department of National Defence or Canadian Forces policy. This paper may not be used without written permission.

© Her Majesty the Queen in Right of Canada, as represented by the Minister of National Defence, 2020.

PCEMI 46

Solo Flight

Avertissement

Les opinons exprimées n'engagent que leurs auteurs et ne reflètent aucunement des politiques du Ministère de la Défense nationale ou des Forces canadiennes. Ce papier ne peut être reproduit sans autorisation écrite.

© Sa Majesté la Reine du Chef du Canada, représentée par le ministre de la Défense nationale, 2020.

Canada

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 46 – PCEMI 46 2019 – 2020

SOLO FLIGHT

CHINESE PEOPLE'S LIBERATION ARMY AIR FORCE MODERNIZATION

By Major Geneviève Vallieres

"This paper was written by a candidate attending the Canadian Forces College in fulfilment of one of the requirements of the Course of Studies. The paper is a scholastic document, and thus contains facts and opinions which the author alone considered appropriate and correct for the subject. It does not necessarily reflect the policy or the opinion of any agency, including the Government of Canada and the Canadian Department of National Defence. This paper may not be released, quoted or copied, except with the express permission of the Canadian Department of National Defence."

Word Count: 5,244

"La présente étude a été rédigée par un stagiaire du Collège des Forces canadiennes pour satisfaire à l'une des exigences du cours. L'étude est un document qui se rapporte au cours et contient donc des faits et des opinions que seul l'auteur considère appropriés et convenables au sujet. Elle ne reflète pas nécessairement la politique ou l'opinion d'un organisme quelconque, y compris le gouvernement du Canada et le ministère de la Défense nationale du Canada. Il est défendu de diffuser, de citer ou de reproduire cette étude sans la permission expresse du ministère de la Défense nationale."

Nombre de mots : 5.244

CHINESE PEOPLE'S LIBERATION ARMY AIR FORCE MODERNIZATION

INTRODUCTION

The Chinese People's Liberation Army Air Force (PLAAF) was established in 1949 and, from the start, it was built on quantity rather than quality.¹ From its inception to the 1990s, the PLAAF fielded a large number of aircraft, making it the third largest air force in the world, but these aircraft were outdated, limited in capability and flown by poorly trained crews.² The PLAAF suffered from an army-centric Chinese military culture³ and from purges within its ranks.⁴ Furthermore, because aerospace is a highly technical field, the PLAAF suffered disproportionally from the effects of the Cultural Revolution, which dismissed technical expertise.⁵

During this period, the Chinese aerospace industry, which supported the PLAFF, was limited to producing copies of Soviet 1950s-era aircraft such as the Ilyushin Il-28 medium bomber, the Tupolev Tu-16 strategic bomber, and the Mikoyan-Gurevich MiG-

¹ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 303.

² *Ibid.*; David A. Deptula, "Foreword," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), xi.

³ Roger Cliff, "The Development of the PLAAF's Doctrine," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 151.

⁴ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 57.

⁵ Roger Cliff, "The Development of the PLAAF's Doctrine," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 151.

17, MiG-19 and MiG-21 fighters.⁶ The Chinese government was convinced that numerical superiority alone was sufficient to guarantee the defence of Chinese airspace.⁷

This Chinese view of air power was shattered by the success of the U.S. Air Force against Saddam Hussein during the 1990-91 Gulf War. This event, combined with changes in the geo-political situation, led the Chinese military to adopt the new strategic concept of fighting "limited local wars under high technology conditions"⁸ in 1997. This period also marked the beginning of continuous increases in defence spending and a reform of the defence industry.⁹ This marked the beginning of sustained efforts to modernize the PLAAF.

The modernization of the PLAAF included upgrading its doctrine, structure, organization, and equipment.¹⁰ This paper will focus on inventory modernization, since it is the most visible and easily quantifiable aspect of the Chinese efforts, and it is indicative of the successes and challenges of the entire modernization effort.

These efforts have resulted in impressive successes over the past twenty years. Although it still operates outdated fighters, the PLAAF is poised to become a majority fourth-generation fighter force within a few years.¹¹ Along with aircraft acquired from Russia, Chinese industry is producing two fourth-generation fighters, the indigenously-

⁶ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 303.

⁷ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 77.

⁸ Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 764.

⁹ Ibid.

¹⁰ Manoj Joshi, "China's Military Modernization and its Implications," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 78.

¹¹ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 269.

developed J-10 and a copy of the Sukhoi Su-27 named the J-11. The Chinese are also developing two fifth-generation fighters, the J-20 and the J-31. Although it is still facing many challenges on its way to modernization, the PLAAF has successfully moved away from a force solely based on mass air defence.¹²

This paper will demonstrate that, starting in the mid-1990s, the PLAAF has aggressively pursued all means available to modernize its inventory. First, it will cover the motivations for the PLAAF modernization. Then, this paper will explain the scope of the PLAAF modernization. Finally, the last section will cover some of the means used by China to modernize the PLAAF inventory. These means will be analyzed using Saunders and Wiseman's "buy, build or steal"¹³ framework.

MOTIVATIONS FOR THE PLAAF MODERNIZATION

The Chinese belief that a numerically superior force equipped with outdated equipment and poorly trained crews would be sufficient to defend Chinese air space was shattered during the Gulf War in 1990-91¹⁴. Air power played a dominant role during Operation Desert Storm, and the technological superiority of the U.S. and its allies allowed them to crush the weaker Iraqi forces. China realized that a weaker force relying on a defensive posture would not be effective against a technologically superior enemy.¹⁵ It also highlighted the vulnerability of China if it had to confront a modern enemy,

¹² Ibid., 448.

¹³ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 272.

¹⁴ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 303.

especially the U.S.¹⁶, and the fact that China had fallen behind the West in both technology and doctrine.¹⁷

This created a sense of urgency to catch up.¹⁸ In 1991, the Chairman of the Central Military Commission and General Secretary of the Communist Party Jian Zemin stated that "the Gulf War makes us further see the functions of science and technology in contemporary war. [...] The functions of science and technology cannot be ignored."¹⁹ By 1993, the People's Liberation Army (PLA) had replaced its doctrine of limited war by a doctrine of "limited war under high technology conditions."²⁰ The PLA started shifting from a purely defensive force to an offensive-defensive force,²¹ and the modernization of the PLAAF got underway.

During the same time period, the geo-political situation was changing. The collapse of the Soviet Union allowed China to start importing Russian weapons in 1991,²² and also allowed it to change its primary focus away from defence against the Soviet

¹⁶ Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 118.

¹⁷ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 78.

¹⁸ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 53.

¹⁹ Jiang Zemin, "Gaodu zhongshi he dali fazhan kexuejishu" ("High Level Advancement and Great Development of Science and Technology"), *Jingji ribao* (8 August 1991): 1, quoted in David Shambaugh, "China's Military in Transition: Politics, Professionalism, Procurement and Power Projection," *The China Quarterly* 146 (1996): 281.

²⁰ David Finkelstein, "China's National Military Strategy: An Overview of the 'Military Strategic Guidelines,'" in *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military*, ed. Roy Kamphausen and Andrew Scobell (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2007), 104.

²¹ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 304.

²² You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 53.

Union and towards preventing Taiwanese independence.²³ The independence of Taiwan was perceived as a challenge to the security and sovereignty of China,²⁴ and the situation was exacerbated by the U.S. show of force in the Taiwan strait in 1996 and the bombing of the Chinese embassy in 1999.²⁵ The Taiwanese push for independence in the mid-1990s and the election of successive pro-independence governments contributed to make a potential conflict in the Taiwan strait the principal focus of the PLAAF.²⁶

The Taiwan strait was not the only area where China felt that it needed the ability to project air power. It needed the ability to dominate the airspace over disputed territories in Northern India, the South China Sea and in the seas of Japan and Korea.²⁷ In 2013, China created an Air Defence Identification Zone (ADIZ) in the South China Sea that included islands disputed with Korea and Japan.²⁸ On the day that the ADIZ was created, the PLAAF was scrambled to enforce it.²⁹

China was also driven by the idea that a strong military would help it achieve great power status, and that this would provide "diplomatic payoff, enhance its regional

²³ Murray S. Tanner, "The Missions of the People's Liberation Army Air Force," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 138.

²⁴ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 78.

²⁵ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 53.

²⁶ *Ibid.*; "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 55.

 ²⁷ Mark A. Stokes, "China's Quest for Joint Aerospace Power: Concepts and Future Aspirations," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 35; Manoj Joshi, "China's Military Modernization and its Implications," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 78.
²⁸ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 132.

²⁹ Ibid., 526.

pre-eminence and as well as protect its interests across the globe."³⁰ To achieve this, China needed an air force that could counter the enhanced U.S. military presence in the Asia-Pacific region following the Cold War.³¹ China's heavy dependence on imports, especially oil, also meant that it required the ability to protect its growing overseas interests.³² All these geo-political factors contributed to the urgency of the efforts to modernize the PLAAF and to complete its shift away from a purely defensive force.

Based on these factors, the PLAAF revised its doctrine in the 1990s. Historically, the service's two main missions had been homeland air defence and support to army and navy operations.³³ The new doctrine marked a shift from this defensive defence posture to a "strategic force capable of launching operations against enemy's defence depth."³⁴ Becoming a strategic force implied that the PLAAF required a defined strategy and missions to directly achieve objectives, modern high-technology platforms, and an institutional status outside of the army's shadow.³⁵ There was also some overlap between the PLAAF's strategic missions and the People's Liberation Army Rocket Force, which is a component of the PLA dedicated to land-based missiles.³⁶

³⁰ Manoj Joshi, "China's Military Modernization and its Implications," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 79.

³¹ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 31.

³² *Ibid.;* Malcom R. Davis, "Future War," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 348.

³³ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 57.

³⁴ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 55.

³⁵ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 5, 12.

³⁶ Mark A. Stokes, "China's Quest for Joint Aerospace Power: Concepts and Future Aspirations," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 45.

China approved the PLAAF's service-specific strategy in 2004.³⁷ The PLAAF started decommissioning older aircraft and introducing modern ones. By 2017, approximately 65% of the PLAAF inventory was made up of fourth generation fighters.³⁸

Finally, this aggressive modernization would not have been possible without the economic boom that followed the decision by the Chinese Communist Party to restructure the economy in 1993.³⁹ This led to a continuous increase in defence budgets that made China the country with the second largest defence spending, after the U.S.⁴⁰

SCOPE OF PLAAF INVENTORY MODERNIZATION

The PLAAF had been a fighter-centric force since its inception. More than 6000 J-6 (copies of Soviet MiG-19s) and J-7 (copies of Soviet MiG-21s) have been manufactured in China, and a large number of J-7s are still in active service.⁴¹ When it set out to modernize its inventory, the PLAAF put a lot of emphasis on fighter aircraft. These will be discussed first, followed by other types of aircraft, which will be discussed later in this section.

In 1995, before the push towards modernization, 80% of the PLAAF combat aircraft inventory was composed of variants of 1950s era Soviet MiG-17 and MiG-19

³⁷ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 9.

³⁸ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 59.

³⁹ Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 121.

⁴⁰ Pratnashree Basu and Rakhahari Chatterji, "China's Race for Arms," *Jadavpur Journal of International Relations* 20, no. 1 (2016): 6.

⁴¹ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 307; Craig Hoyle, Flight Global, "Analysis: 2019 World Air Forces Directory," accessed 19 April 2020, https://www.flightglobal.com/analysis/analysis-2019-world-air-forcesdirectory/130525.article.

fighters.⁴² The modernization of this inventory started in 1992, with the purchase of 74 Su-27 multi-role air superiority fighters from Russia. These were the first fourthgeneration fighters to enter the PLAAF inventory. In 1996, China entered in an agreement with Russia for the licensed production of 200 Su-27s, which were named J-11, and the same year, China purchased 76 Su-30MKK multi-role fighters from Russia.⁴³

In the early 2000s, China developed the J-11B. Based on the Su-27, the improved J-11B featured Chinese avionics, engines, radar and weapons.⁴⁴ The aircraft was designed to compete with U.S. F-15 and F/A-18 aircraft.⁴⁵ For tactical strikes, China domestically developed the JH-7A fighter-bomber.⁴⁶ In 2003, the domestically-developed J-10 multi-role fighter entered service. This aircraft was roughly in the same class as the U.S. F-16C, with fly-by-wire controls, a glass cockpit and Russian engines.⁴⁷ It is currently one of the platform with the largest number of airframes in the PLAAF inventory.⁴⁸

China is also working on the development of two fifth-generation stealth fighters. These aircraft should have high maneuverability, low observability, internal weapons bays, modern avionics and sensors and electronic warfare systems.⁴⁹ However, the

⁴² David Shlapak, "Equipping the PLAAF: The Long March to Modernity," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 191.

⁴³ Ibid., 196.

⁴⁴ Ibid.

⁴⁵ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 59.

⁴⁶ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 306.

⁴⁷ Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 777.

⁴⁸ Craig Hoyle, Flight Global, "Analysis: 2019 World Air Forces Directory," accessed 19 April 2020, https://www.flightglobal.com/analysis/analysis-2019-world-air-forces-directory/130525.article.

⁴⁹ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 270.

performance details available for both of these aircraft are "sketchy."⁵⁰ The first fifthgeneration fighter to be developed was the J-20. It entered service in 2017 and there are currently at least ten in the PLAAF inventory.⁵¹ This is a large, long-range fighter, likely intended to compete with the F-22.⁵² The second is the J-31. Its first flight took place in 2012, and it is not yet in production.⁵³ It is probably a modern air-to-air fighter with multi-mission capabilities intended to be similar to the F-35.⁵⁴

Another type of aircraft that was a high priority for modernization starting in the late 1990s was the Airborne Early Warning and Control System (AWACS) aircraft. China sought to purchase these platforms but was unsuccessful, and had to develop them indigenously.⁵⁵ Two AWACS were originally developed: the high-end KJ-2000 and the low-end KJ-200. The KJ-2000 entered service in 2007 and was based on the Soviet Ilyushin Il-76 transport aircraft. The smaller and less capable KJ-200 was based on the Y-8 airframe, which is a copy of the Soviet Antonov An-12 transport aircraft.⁵⁶ Following the introduction of the KJ-2000, China was unsuccessful at procuring Il-76 platforms

⁵⁰ Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 778.

⁵¹ Craig Hoyle, Flight Global, "Analysis: 2019 World Air Forces Directory," accessed 19 April 2020, https://www.flightglobal.com/analysis/analysis-2019-world-air-forces-directory/130525.article.

⁵² "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 60.

⁵³ Minnie Chan, "China Unveils New Fifth-Generation Stealth Fighter," *South China Morning Post*, 31 October 2012, accessed 19 April 2020, https://www.scmp.com/news/china/article/1074027/china-adds-new-fifth-generation-stealth-fighter-arsenal.

⁵⁴ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 60.

⁵⁵ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 19.

⁵⁶ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 306.

from Russia,⁵⁷ and only four KJ-2000s were built. This was insufficient to meet the needs of the PLAAF.⁵⁸

In the late 2000s, China started the development of a more modern, medium size AWACS, the KJ-500. This system was based on the Y-9 airframe, an improved version of the Y-8.⁵⁹ There is not a lot of information available on the capabilities of any of those Chinese AWACS platforms.⁶⁰

To truly transform itself into a strategic service, the PLAAF would also require strategic transport aircraft. The ability to rapidly reach areas of interest is key to establishing a strategic air force. The PLAAF, however, has historically lacked strategic lift capabilities, relying on a small number of soviet Ilyushin Il-76 transport aircraft.⁶¹ China ordered 34 Il-76 aircraft from Russia in 2008, but Russia failed to deliver them. To modernize its strategic transport fleet, and because it could not rely on Russia, China developed the Y-20 heavy transport aircraft. This aircraft is based on Il-76 technology, and is similar in appearance to the C-17.⁶² The Y-20, which is powered by the same

⁵⁷ Ravinder Singh Chhatwal, "'Far Vision' for the Dragon: China's Indigenous AWACS Projects," Vayu Aerospace and Defence Review 5, (September-October 2018): 55.

⁵⁸ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 19.

⁵⁹ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 306.

⁶⁰ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 306.

⁶¹ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 16.

⁶² Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 307.

Russian engines as the Il-76, entered service in 2016.⁶³ China also plans to use the Y-20 platform for AWACS and air-to-air refueling aircraft.⁶⁴

Air-to-air refueling (AAR) is another capability that is required by a strategic air force to extend the range of its combat aircraft. China's AAR capabilities have been historically very limited, and it does not appear to be an area of priority for the PLAAF modernization. This is surprising, since this lack of AAR capabilities limits the ability of the PLAAF to project power to no more than a few hundred kilometers from its territory.⁶⁵ Currently, China only operates approximately ten converted H-6 1950s-era bombers and three more modern Ilyushin Il-78 MIDAS tankers purchased from the Ukraine. The situation is aggravated by a lack of commonality between the refueling systems on Russian and Chinese aircraft.⁶⁶

The artificial islands that China has been building off its coast can be seen a solution to extend the range of PLAAF aircraft without requiring AAR. However, these islands are not a solution for global power projection.⁶⁷ China's longer term plan appears to be the conversion of some of its Y-20 transport aircraft to AAR platforms.⁶⁸

⁶³ Ravinder Singh Chhatwal, "'Far Vision' for the Dragon: China's Indigenous AWACS Projects," Vayu Aerospace and Defence Review 5, (September-October 2018): 57; "The Dragon's Claws: Assessing China's PLAAF Today," Vayu Aerospace and Defence Review 4, (July-August 2017): 60.

⁶⁴ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 17.

⁶⁵ David Shlapak, "Equipping the PLAAF: The Long March to Modernity," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 207.

⁶⁶ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 59; "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 62.

⁶⁷ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 60.

⁶⁸ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 62.

The capabilities of the PLAAF are also limited in the area of long range strikes. The PLAAF's only strategic bomber platform is the H-6, which is adapted from the 1950s Soviet Tupolev Tu-16 platform.⁶⁹ China is currently working on the development of the H-20, which is a long-range stealth bomber similar in design to the Northrop-Grumman B-2. It could be ready to enter service as early as 2025.⁷⁰

China has also developed a large number of Unmanned Aerial Vehicles and Unmanned Combat Aerial Vehicles over the last few years, many of which have not entered service.⁷¹ Other areas of inventory modernization include surface-to-air defences, air-to-air and air-to-surface weapons, space and counter-space capabilities.⁷² These systems will not be covered in details in this paper, but are part of the PLAAF modernization.

The PLAAF's modernization efforts have not consisted solely of modernizing inventory. Major organizational changes have been implemented that have reduced the total number of aircraft to achieve a smaller but better equipped and higher technology force. The total inventory of fighters, bombers and support aircraft in the PLAAF and the People's Liberation Army Navy Air Force (PLANAF) was 5300 in 2000 and had been reduced to 2300 by 2010.⁷³ As part of this reduction, the fraction of the inventory made

⁶⁹ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 18.

⁷⁰ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 60.

⁷¹ Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 19.

⁷² David Shlapak, "Equipping the PLAAF: The Long March to Modernity," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 207; Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force," *Journal of Strategic Studies* 39, no. 1 (September 2015): 16.

⁷³ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 80.

up of fighter-interceptor aircraft went down from approximately 80% in 1995 to approximately 50% in 2015.⁷⁴ This shows a diversification of the force structure, no longer focused solely on air defence.⁷⁵

This paper is focused on equipment modernization, but, of course, other areas of the PLAAF also had to be modernized along with its inventory. Doctrine, training, procurement services, interoperability and human resources management are all areas of the PLAAF that China has worked at modernizing.⁷⁶ In the area of personnel policies, for example, modernization efforts have resulted in a smaller force with improved combat and leadership skills.⁷⁷ There has also been a shifting balance from the army to the navy and air force, resulting in 2014 with the announcement that China would adopt a joint structure, similar to that used in western militaries.⁷⁸

Finally, this section has demonstrated that China has made substantial efforts to modernize the PLAAF. However, despite all these successful initiatives, it has not yet achieved a force with global reach. This is due to weaknesses in joint integration, air-to-air refueling and aircraft production and sustainment.⁷⁹ Similarly, for all its historical focus on national air defence, China does not have a single national air command responsible for air defence, resulting in a poor coordination between services.⁸⁰ Another

⁷⁴ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 278.

⁷⁵ Ibid., 267.

⁷⁶ Ibid., 174.

⁷⁷ Ibid., 292.

⁷⁸ Pratnashree Basu and Rakhahari Chatterji, "China's Race for Arms," *Jadavpur Journal of International Relations* 20, no. 1 (2016): 26.

⁷⁹ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 56.

⁸⁰ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 87.

major obstacle for the PLAAF modernization is its lack of combat experience. The PLAAF's last major combat operations were in the Jinmen campaign of 1958.⁸¹

The most serious obstacle to PLAAF modernization is probably the PLA's political culture, traditions, and outdated organizational systems.⁸² This highly hierarchical and centralized system affects all aspects of the PLAAF, resulting, for example, in the "inability of their pilots to make decisions,"⁸³ including on things such as route and tactics changes in flight. This aspect has been designed into the Chinese military out of a concern that troops that would "develop themselves into professional warriors"⁸⁴ would lose their absolute loyalty to the regime and political leaders. This aspect has negated some of the gains in effectiveness achieved through the PLAAF modernization.

MEANS OF PLAAF INVENTORY MODERNIZATION

Saunders and Wiseman describe the means for a country with a relatively backwards aviation industry to modernize its air force as "buy, build or steal".⁸⁵ They also describe hybrid approaches, which combine elements of buy, build and steal. These are reverse engineering, coproduction and co-development.⁸⁶ In its efforts to rapidly

⁸¹ Roger Cliff, "The Development of the PLAAF's Doctrine," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 160.

⁸² Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 88.

⁸³ Lyle J. Morris, "China's Air Force is Fixing its Shortcomings," *The Rand Blog*, 14 October 2016, https://www.rand.org/blog/2016/10/chinas-air-force-is-fixing-its-shortcomings.html.

⁸⁴ James Char and Richard A. Blitzinger, "A New Direction in the People's Liberation Army's Emergent Strategic Thinking, Roles and Missions," *The China Quarterly* 232, (December 2017): 861.

⁸⁵ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 272.

⁸⁶ Ibid., 275.

modernize PLAAF equipment, China has used all of these approaches. It has also extensively used imported civilian technology, or dual-use technology, to modernize its military.⁸⁷ The details of China's use of buy, build and steal will be covered in this section.

Buy

When the PLAAF modernization efforts started, the Chinese military aerospace industry was unable to meet the demand for advanced weapon systems. Armament imports were a means to rapidly acquire weapon systems, while simultaneously accessing foreign technology and knowledge to improve the indigenous industry.⁸⁸ These import investments have made China the second largest weapons importer of the post-Cold War (1990 to 2015). To get a scale of the Chinese imports efforts, China had imported \$5 million of weapons in 1980. That number had risen to \$4 billion by 2006.⁸⁹

By far, the biggest exporter of weapon systems to China and the PLAAF since the 1990s has been Russia. The west had imposed an arms embargo on China following the events at Tiananmen Square in 1989, so China's options were limited. At the same time, following the collapse of the Soviet Union, Russia was eager to find export markets which were now essential to the survival of its armament industry.⁹⁰ As a result, China

⁸⁷ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 179.

 ⁸⁸ Hugo Meijer, Lucie Béraud-Sudreau, Paul Holtom and Matthew Uttley, "Arming China: Major Power's Arms Transfers to the People's Republic of China," *Journal of Strategic Studies* 41, no. 6 (2018): 850.
⁸⁹ Rachel Stohl and Suzette Grillot, *The International Arms Trade* (Cambridge, U.K.: Polity Press, 2009), 74.
⁹⁰ Hugo Meijer, Lucie Béraud-Sudreau, Paul Holtom and Matthew Uttley, "Arming China: Major Power's Arms Transfers to the People's Republic of China," *Journal of Strategic Studies* 41, no. 6 (2018): 873.

started importing Russian weapons in 1991.⁹¹ Between 1992 and 2015, China accounted for 27% of Russian arms exports, and Russia accounted to 80% of Chinese arms imports.⁹²

In 1992, China purchased Sukhoi S-27 fighters, and in 1996, it began the licensed production of S-27s under the name J-11. This was an important step for the PLAAF and for the Chinese aircraft industry, bringing them from third to fourth generation fighter aircraft. The contract was negotiated directly by Sukhoi, who was focusing on the survival of the company, and was approved by Moscow only after the fact. Originally, the contract with Sukhoi specified that the licensed aircraft would be fitted with Russian engines, radars and avionics, which would not be licensed for Chinese production. China eventually abrogated the terms of the contract and developed its own version of the J-11, which led to substantial friction with Russia, who refused to enter into further military transfer agreements with China in 2006.⁹³ In 2008, China and Russia entered into an intellectual property agreement, which allowed China to produce for its own use, but not for export. This agreement allowed further military collaboration between the two countries.⁹⁴

In 1996, China purchased Sukhoi Su-30MKK fighters. Chinese industry used the technology from these more advanced fighters to produce the J-11B/D and J-16

⁹² Hugo Meijer, Lucie Béraud-Sudreau, Paul Holtom and Matthew Uttley, "Arming China: Major Power's Arms Transfers to the People's Republic of China," *Journal of Strategic Studies* 41, no. 6 (2018): 871.
⁹³ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 303.

⁹¹ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 53.

⁹⁴ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 60.

fighters.⁹⁵ The Su-30MKK fighter was not the best fighter that Russia could produce at the time, but it was a substantial technological leap forward for the PLAAF.⁹⁶

Russia had been hesitant to sell the most advanced version of its weapon systems to China. It also wanted to limit China's ability to export derivatives of Russian weapon systems and compete with its foreign sales. Finally, Russia favored the sale of hardware to China, not the transfer of technology. The reason for these limitations was that China's rise in economic and military power was viewed with nervousness by Russian security experts. This has in turn caused frustrations and a declining desire to buy Russian systems in China.⁹⁷ However, China will need to continue purchasing Russian systems for years to come, to compensate for the weakness of their military aerospace industry in some areas, such as helicopter and engine manufacturing.⁹⁸

Since the 1990s, Russia has been by far the largest exporter of armament to China, but it has not been the only one. Imports from Israel have also played a role in the modernization of the PLAAF inventory. The height of Chinese-Israeli armament transfers was 1984, with arms sales reaching \$3.5 billion that year, and Israel was still the second largest source of military transfers to China through the 1990s.⁹⁹

⁹⁵ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 305.

⁹⁶ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 304.

⁹⁷ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 59.

⁹⁸ Ibid., 62.

⁹⁹ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 305.

China and Israel had a secret contract in the 1980s to introduce technology from the cancelled U.S.-financed Israeli Lavi fighter aircraft into the Chinese J-10.¹⁰⁰ The exact amount and type of assistance is unknown, but Israel had a role in modernizing the PLAAF fighters.¹⁰¹ In 2001, a U.S. EP-3E surveillance aircraft collided with a Chinese J-8 interceptor. The pictures taken by the EP-3E during the event showed Israeli-made Python 3 missiles on the J-8.¹⁰²

The same year, the U.S. convinced Israel to cancel a contract estimated at \$1 billion for the sale of Phalcon airborne radars to China. In the words of a senior U.S. official at the time: "the idea that a country that is a close friend to the U.S., that we provide billions in military aid to, would in turn sell weapons and technology to a country that would turn them back on the U.S. was obviously problematic"¹⁰³ Even though the Phalcon contract was cancelled, China was able to use some of the Israeli technology: the transmit/receive module, the production process for the composite material radome, and the design of the radar structure. This technology was used to develop the indigenous Chinese AWACS.¹⁰⁴

¹⁰⁰ Shen Pin-Luen, "China's Aviation Industry: Past, Present, and Future," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 263.

¹⁰¹ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 305.

 ¹⁰² Rachel Stohl and Suzette Grillot, *The International Arms Trade* (Cambridge, U.K.: Polity Press, 2009), 74.
¹⁰³ Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 246.

¹⁰⁴ Ravinder Singh Chhatwal, "'Far Vision' for the Dragon: China's Indigenous AWACS Projects," *Vayu Aerospace and Defence Review* 5, (September-October 2018): 54.

In 2004, the U.S. convinced Israel to cancel a contract to upgrade the fleet of Harpy UAVs originally sold to China in 1994. Israel subsequently strengthened its export controls, and this marked the end of the Chinese-Israeli military collaboration.¹⁰⁵

Europe has also exported military technology to China, despite the 1989 embargo.¹⁰⁶ China had pushed hard for the European Union to lift the embargo.¹⁰⁷ France was the key European driver for this initiative, which came close to success in 2003-2005. However, strong U.S. pressures against lifting the embargo and the adoption in 2005 by China of its Anti-Secession Law that authorizes the use of force against Taiwan should it declare independence, killed this initiative.¹⁰⁸

Despite the embargo, France has sold approximately \$1.2 billion in armament to China since the 1980s, followed by Germany with \$339 million and the U.K. with \$242 million.¹⁰⁹ Examples of exports that contributed to modernize the PLAAF include the export of six Searchwater airborne early warning radars by the U.K. in 1996, which were incorporated in the Chinese KJ-200 AWACS. The U.K. also provided Spey turbofan engines for the JH-7 fighter-bomber.¹¹⁰ France has exported a number of attack and transport helicopters, even collaborating with China on the joint production of the H175/AC352 utility helicopter.¹¹¹

¹⁰⁵ Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 247.

¹⁰⁶ Rachel Stohl and Suzette Grillot, *The International Arms Trade* (Cambridge, U.K.: Polity Press, 2009), 75. ¹⁰⁷ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 53.

¹⁰⁸ Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 248.

 ¹⁰⁹ Rachel Stohl and Suzette Grillot, *The International Arms Trade* (Cambridge, U.K.: Polity Press, 2009), 75.
¹¹⁰ Hugo Meijer, Lucie Béraud-Sudreau, Paul Holtom and Matthew Uttley, "Arming China: Major Power's Arms Transfers to the People's Republic of China," *Journal of Strategic Studies* 41, no. 6 (2018): 863.
¹¹¹ *Ibid.*, 867.

Even the U.S., who has strong export restrictions of military technology to China, has been used in the PLAAF's modernization efforts. High-technology dual-use components that have been exported to China have found usage in the military. Information technologies, for example, have allowed China to steadily improve its Command Control Communications Computer Intelligence Surveillance and Reconnaissance (C⁴ISR) capabilities.¹¹² In 2002, the U.S.-China Commission warned that "China had made significant efforts to acquire sensitive technologies from foreign suppliers, and had implemented programs directed at leveraging dual-use technologies through indigenous R&D as well as foreign joint ventures."¹¹³

China is expected to continue to rely on armament imports, especially for helicopters, radars and engines, for years to come.¹¹⁴ Overall, however, the volume of Chinese arms imports has declined substantially, by 42% between 2005 and 2015,¹¹⁵ as the indigenous armament industry improved. Overall, the import of aircraft, air-defence systems and missiles has been declining, while the import of engines has been increasing. The reason for this will be covered in the following subsection.

Build

Because of the 1989 arms embargo and its reluctance to rely on Russia as its sole supplier of armament, China had no choice but to modernize its military aerospace

¹¹² Hugo Meijer, *Trading with the Enemy* (New York: Oxford University Press, 2016), 255.

¹¹³ U.S. Department of Defense Office of the Secretary of Defense, *The Military Power of the People's Republic of China*, (Washington, D.C.: U.S. Government Printing Office, 2006), 2.

¹¹⁴ Anthony H. Cordesman, Steven Colley, and Michael Wang, Chinese Strategy and Military

Modernization in 2015: A Comparative Analysis (Washington D.C.: Center for Strategic and International Studies, 2015), 180.

¹¹⁵ Pratnashree Basu and Rakhahari Chatterji, "China's Race for Arms," *Jadavpur Journal of International Relations* 20, no. 1 (2016): 8.

industry in order to modernize the PLAAF. Prior to the 1990s, the Chinese military aerospace industry had only produced copies of 1950s-era Soviet aircraft.¹¹⁶ Its ability to invent and innovate was extremely limited.¹¹⁷ To improve it, China restructured its aviation industry in 1999 and again in 2008 to make it more market-oriented and provided it with new funding and technologies.¹¹⁸ Furthermore, China increased its military research and development (R&D) spending, which is estimated to have reached between U.S.\$5 billion and U.S.\$10 billion in 2015, making China the second or third largest spender on military R&D in the world.¹¹⁹

These structural changes to its military aviation industry have resulted in a lot of successes for the PLAAF. Building on the Su-27s first purchased from Russia in 1992, China had developed the much more advanced J-11B/D fighter and the J-16 fighter-bomber with an indigenously developed datalink similar to the U.S. Link-16.¹²⁰ The PLAAF's eventual decision to buy J-11Bs instead of more Russian Su-30s showed its increased confidence in Chinese industry.¹²¹

¹¹⁶ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 305.

¹¹⁷ Shen Pin-Luen, "China's Aviation Industry: Past, Present, and Future," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 266.

¹¹⁸ *Ibid.*,265; Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 763.

 ¹¹⁹ James Char and Richard A. Blitzinger, "A New Direction in the People's Liberation Army's Emergent Strategic Thinking, Roles and Missions," *The China Quarterly* 232, (December 2017): 853.
¹²⁰ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 305-6.

¹²¹ David Shlapak, "Equipping the PLAAF: The Long March to Modernity," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 208.

After a decade of efforts, the J-10 multi-role fighter entered PLAAF service in 2003 as the first indigenously-developed fourth generation fighter.¹²² It has since been continuously upgraded and more than 250 are currently in service, with more expected to replace the obsolete J-7s.¹²³ Other indigenously developed, modern aircraft currently in PLAAF service include the JH-7 fighter-bomber, three different AWACS: the KJ-2000, KJ-200 and KJ-500, and the Y-20 heavy transport.¹²⁴

China is also the only country besides the U.S. with two fifth-generation fighter programs under development: the J-20, which is currently in service and the J-31, currently under development.¹²⁵ Other programs under development include the Z-20 medium helicopter and the H-20 long-range bomber.¹²⁶ Through all these programs, China has demonstrated its ability to indigenously develop its own weapon systems, and that it does not have to rely on imports to modernize the PLAAF.¹²⁷

For all the improvements since the 1990s, there are still issues with the Chinese military aerospace industry. Some analysts would argue that aircraft production and sustainment is one of the PLAAF's major weaknesses.¹²⁸

¹²³ *Ibid.*; Craig Hoyle, Flight Global, "Analysis: 2019 World Air Forces Directory," accessed 19 April 2020, https://www.flightglobal.com/analysis/analysis-2019-world-air-forces-directory/130525.article.
¹²⁴ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen

¹²² Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 306.

⁽Abingdon: Routledge, 2018), 306-7.

¹²⁵ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 285.

¹²⁶ Xiaoming Zhang, "Chinese Air Power," in *Routledge Handbook of Air Power*, ed. John A. Olsen (Abingdon: Routledge, 2018), 307.

 ¹²⁷ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 179.

¹²⁸ Jonathan G. McPhilamy, "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 56.

The firms making up the Chinese military aircraft industry are state-owned, and have no competition. They have been plagued by delays, cost overruns, quality control issues, corruption and bureaucratic fragmentation.¹²⁹ There is inadequate investment in R&D, and a low ability for independent innovation and invention, which has resulted in most programs being the result of suspected piracy or outright copies.¹³⁰

When Chinese industry first assembled Russian-purchased Su-27 kits in 1997, they were of such poor quality that Russian technicians had to re-build them. The Chinese improved rapidly, and by 2002, they were producing the aircraft at a high level of quality. However, several cases of parts smuggling from Russia since 2008 seem to indicate Chinese issues with parts manufacturing for the aircraft.¹³¹ Similarly, the successful Chinese-developed J-10 took 20 years from start of production to entering service and the production runs were often small and fitful.¹³²

These issues are mostly apparent in the area of engine manufacturing. China has some engine manufacturing capabilities, but its engines have short overhaul intervals and are slow to accelerate to maximum power, making them less than ideal.¹³³ Lin Zuoming, the head of Aviation Industries of China has admitted in 2009 that China's most

 ¹²⁹ Keith Hartley, *The Economics of Arms* (Newcastle upon Tyne, U.K.: Agenda Publishing, 2017), 99-100.
¹³⁰ Shen Pin-Luen, "China's Aviation Industry: Past, Present, and Future," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 266.

¹³¹ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 303.

¹³² Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 766.

¹³³ Shen Pin-Luen, "China's Aviation Industry: Past, Present, and Future," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 265.

advanced turbofan was "unsatisfactory in its quality"¹³⁴. This is the reason why, while overall armament imports are decreasing, the import of engines to China is rising.¹³⁵

Engine technology should be an area of concern for the PLAAF, since it affects operations. The newly introduced Y-20 transport suffers from engine quality control issues, reducing the operational availability of the aircraft.¹³⁶ Similarly, engine availability issues have been plaguing the II-76 transport aircraft fleet, as well as the KJ-2000 AWACS which is based on the platform.¹³⁷ The maintenance requirements for all these problematic engines would remove a large number of aircraft from service in case of long-term operations. Therefore, the "PLAAF's ability to maintain long-term strategic superiority remains suspect."¹³⁸

Steal

China used both illegal reverse engineering, traditional piracy and espionage, as well as cyber-espionage to develop the weapon systems required to modernize the PLAAF. These methods will be covered in this sub-section.

China used reverse engineering legally to develop its military aviation industry.

The licensed production of the Su-27, in particular, allowed China to learn to build

¹³⁴ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 311.

¹³⁵ Pratnashree Basu and Rakhahari Chatterji, "China's Race for Arms," *Jadavpur Journal of International Relations* 20, no. 1 (2016): 12.

¹³⁶ "The Dragon's Claws: Assessing China's PLAAF Today," *Vayu Aerospace and Defence Review* 4, (July-August 2017): 61.

¹³⁷ Ibid., 63.

¹³⁸ Ibid., 59.

modern combat aircraft.¹³⁹ However, China also used illegal reverse-engineering extensively. Around 2000-2001, China gained access to a Sukhoi Su-33 carrier-based fighter from the Ukraine, which it used to develop its J-15 naval fighter.¹⁴⁰ It is also assumed that China had access to a Pakistani F-16, and possibly to F-16 technology through Israel, in the 1980s.¹⁴¹

Almost all of the weapon systems imported from Russia have been copied illegally and incorporated into Chinese systems. The smaller volume of Israeli and European weapons have similarly been copied.¹⁴² Possibly the most well-known case of illegal Chinese reverse-engineering is the violation of the contract to produce J-11 fighters based on the Su-27 platform in 2004. China and Russia eventually came to an intellectual property rights agreement in 2008, but by then there had been a loss of thrust and increased friction between the two countries based on Chinese copying.¹⁴³

China is "engaged in a multipronged effort to gain foreign advanced technologies through both legal and illegal means. These include . . . industrial espionage (both traditional and, increasingly, cyber-espionage)."¹⁴⁴ On the traditional side, there have

¹³⁹ You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 54.

¹⁴⁰ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities,* ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 307.

¹⁴¹ Ibid., 277.

¹⁴² Simenon T. Wezeman, "The Global Arms Trade after the Cold War," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 198.

¹⁴³ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 313; You Ji, "Friends in Need or Comrades in Arms," in *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (London U.K.: Routledge, 2010), 60.

¹⁴⁴ Richard A. Bitzinger, "Reforming China's Defense Industry," *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 785.

been many cases of illegal activities that would have contributed to the modernization of Chinese military equipment. Here are some examples:

- In 2010, Noshir Gowadia, a former Northrop-Grumman employee involved in the development of the B-2 bomber, was convicted of providing China with technology to develop low-signature cruise missile exhaust systems.
- In 2010, Chi Tong Kuok was convicted for conspiring to export U.S. military encryption technology to China.
- In 2012, Yan Bin was arrested for attempting to export military-grade accelerometers used in aircraft and missiles to China.
- In 2013 Ma Lisong pleaded guilty of attempting to export weapons-grade carbon fiber to China.¹⁴⁵

These are only a few examples of numerous similar documented cases. Cyberespionage is also suspected to be widely used by China, but is more difficult to attribute, or to trace to military end-users. In 2004, attacks on U.S. military and defence contractor networks were traced back to China. This cyber-attack reportedly resulted in the theft of U.S. Army helicopter planning system and Falconview flight planning software.¹⁴⁶ A 2009 attack on the network of BAE Systems, a contractor on the F-35 fighter program, resulted in sensitive data being accessed by the alleged Chinese hackers.¹⁴⁷

¹⁴⁵ Anthony H. Cordesman, Steven Colley, and Michael Wang, *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis* (Washington D.C.: Center for Strategic and International Studies, 2015), 196-7.

 ¹⁴⁶ Phillip C. Saunders and Joshua K. Wiseman, "China's Quest for Advanced Aviation Technologies," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 308.
¹⁴⁷ Ibid.

As the technology used in its military aerospace industry becomes more advanced, it also becomes more difficult to develop. It is therefore likely that China will rely increasingly on espionage to acquire technologies that it cannot purchase or develop on its own.¹⁴⁸

CONCLUSION

This paper discussed the modernization of the PLAAF inventory. First, it explained the motivations leading to the PLAAF modernization, then it detailed the scope of inventory modernization. Finally, the paper described the means of inventory modernization, focusing on the "buy, build, steal" framework of Saunders and Wiseman. Through this analysis, this paper has shown that, starting in the mid-1990s, the PLAAF has aggressively pursued all means available to modernize its inventory.

China has been highly successful in its PLAAF modernization program. From a defensive force composed exclusively of 1950s-era Soviet aircraft in the early 1990s to the modern strategic air force of today, there is a marked, even spectacular improvement. However, to really become a modern, strategic force, there are still a few issues that need to be addressed.

The higher the technology level in the PLAAF becomes, the more improvements become difficult and costly to achieve. The Chinese difficulties in this area were discussed in the paper, but they will represent a challenge for the PLAAF in years to come.¹⁴⁹ However, the most serious challenge that the PLAAF faces in its modernization

¹⁴⁸ *Ibid.*, 311.

¹⁴⁹ *Ibid.*, 316.

efforts is cultural. It is easier to acquire modern aircraft and develop new doctrine than it is to develop the institutional culture required to fully exploit them.¹⁵⁰ The ability of the PLAAF to fully modernize will depend on training and leadership.¹⁵¹ The future will tell whether the PLAAF modernization was a successful effort or not.

¹⁵⁰ Xiaoming Zhang, "The PLAAF's Evolving Influence within the PLA and upon National Policy," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 72.

¹⁵¹ Roger Cliff, "The Development of the PLAAF's Doctrine," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff and Phillip C. Saunders (Washington D.C.: National Defense University Press, 2012), 160.

BIBLIOGRAPHY

- Basu, Pratnashree and Rakhahari Chatterji. "China's Race for Arms." *Jadavpur Journal* of International Relations 20, no. 1 (2016): 1-32.
- Bitzinger, Richard A. "Reforming China's Defense Industry." *Journal of Strategic Studies* 39, no. 5-6 (September 2016): 762-89.
- Char, James and Richard A. Blitzinger. "A New Direction in the People's Liberation Army's Emergent Strategic Thinking, Roles and Missions." *The China Quarterly* 232, (December 2017): 841-865.
- Chase Michael S. and Cristina L. Garafola. "China's Search for a 'Strategic Air Force."" Journal of Strategic Studies 39, no. 1 (September 2015): 4-28.
- Chhatwal, Ravinder Singh. "'Far Vision' for the Dragon: China's Indigenous AWACS Projects." *Vayu Aerospace and Defence Review* 5, (September-October 2018): 53-57.
- Cliff, Roger. "The Development of the PLAAF's Doctrine." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 149-164. Washington D.C.: National Defense University Press, 2012.
- Cordesman, Anthony H., Steven Colley, and Michael Wang. *Chinese Strategy and Military Modernization in 2015: A Comparative Analysis.* Washington D.C.: Center for Strategic and International Studies, 2015.
- Davis, Malcom R. "Future War." In *The Global Arms Trade: A Handbook*, edited by Andrew T.H. Tan, 344-57. London U.K.: Routledge, 2010.
- Deptula, David A. "Foreword." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, xi-xii. Washington D.C.: National Defense University Press, 2012.
- Finkelstein, David. "China's National Military Strategy: An Overview of the 'Military Strategic Guidelines." In *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military*, edited by Roy Kamphausen and Andrew Scobell, 69-140. Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2007.
- Hartley, Keith. *The Economics of Arms*. Newcastle upon Tyne, U.K.: Agenda Publishing, 2017.

- Hoyle, Craig. Flight Global. "Analysis: 2019 World Air Forces Directory." Accessed 19 April 2020. https://www.flightglobal.com/analysis/analysis-2019-world-airforces-directory/130525.article.
- Ji, You. "Friends in Need or Comrades in Arms." In *The Global Arms Trade: A Handbook*, edited by Andrew T.H. Tan, 52-64. London U.K.: Routledge, 2010.
- Joshi, Manoj. "China's Military Modernization and its Implications." *Vayu Aerospace* and Defence Review 4, (July-August 2017): 78-84.
- McPhilamy, Jonathan G. "Air Supremacy: Are the Chinese Ready?" *Military Review*, January-February 2020, 56-61.
- Meijer, Hugo. Trading with the Enemy. New York: Oxford University Press, 2016.
- Meijer, Hugo, Lucie Béraud-Sudreau, Paul Holtom and Matthew Uttley. "Arming China: Major Power's Arms Transfers to the People's Republic of China." *Journal of Strategic Studies* 41, no. 6 (2018): 850-886.
- Saunders, Phillip C. and Joshua K. Wiseman. "China's Quest for Advanced Aviation Technologies." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 271-323. Washington D.C.: National Defense University Press, 2012.
- Shambaugh, David. "China's Military in Transition: Politics, Professionalism, Procurement and Power Projection." *The China Quarterly* 146 (1996): 265-98.
- Shen Pin-Luen. "China's Aviation Industry: Past, Present, and Future." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 257-270. Washington D.C.: National Defense University Press, 2012.
- Shlapak, David. "Equipping the PLAAF: The Long March to Modernity." In *The Chinese* Air Force: Evolving Concepts, Roles, and Capabilities, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 191-211. Washington D.C.: National Defense University Press, 2012.
- Stohl, Rachel and Suzette Grillot. *The International Arms Trade*. Cambridge, U.K.: Polity Press, 2009.
- Stokes, Mark A. "China's Quest for Joint Aerospace Power: Concepts and Future Aspirations." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 33-70. Washington D.C.: National Defense University Press, 2012.

- Tanner, Murray S. "The Missions of the People's Liberation Army Air Force." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 133-148. Washington D.C.: National Defense University Press, 2012.
- "The Dragon's Claws: Assessing China's PLAAF Today." Vayu Aerospace and Defence Review 4, (July-August 2017): 54-65.
- United States. U.S. Department of Defense Office of the Secretary of Defense. *The Military Power of the People's Republic of China*. Washington, D.C.: U.S. Government Printing Office, 2006.
- Wezeman, Simenon T. "The Global Arms Trade after the Cold War." In *The Global Arms Trade: A Handbook*, edited by Andrew T.H. Tan, 193-207. London U.K.: Routledge, 2010.
- Zhang, Xiaoming. "Chinese Air Power." In *Routledge Handbook of Air Power*, edited by John A. Olsen, 301-312. Abingdon: Routledge, 2018.
- —. "The PLAAF's Evolving Influence within the PLA and upon National Policy." In *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, edited by Richard P. Hallion, Roger Cliff and Phillip C. Saunders, 71-92. Washington D.C.: National Defense University Press, 2012.