

U.S.-China Aviation Competition

Military, Commercial, and General Aviation Are Different

Chad J. R. Ohlandt

CT-A2692-1

Testimony presented before the U.S.-China Economic and Security Review Commission on April 13, 2023.



For more information on this publication, visit www.rand.org/t/CTA2692-1.

Testimonies

RAND testimonies record testimony presented or submitted by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies.

Published by the RAND Corporation, Santa Monica, Calif.

© 2023 RAND Corporation

RAND® is a registered trademark.

Limited Print and Electronic Distribution Rights

This publication and trademark(s) contained herein are protected by law. This representation of RAND intellectual property is provided for noncommercial use only. Unauthorized posting of this publication online is prohibited; linking directly to its webpage on rand.org is encouraged. Permission is required from RAND to reproduce, or reuse in another form, any of its research products for commercial purposes. For information on reprint and reuse permissions, please visit www.rand.org/pubs/permissions.

www.rand.org

U.S.-China Aviation Competition: Military, Commercial, and General Aviation Are Different

Testimony of Chad J.R. Ohlandt¹
The RAND Corporation²

Before the U.S.-China Economic and Security Review Commission

April 13, 2023

A viation comes in three flavors: military aviation, commercial aviation, and general aviation. Military aviation is driven by performance demands—speed, radars, stealth, short or vertical takeoff. Commercial aviation emphasizes safety, reliability, and efficiency. General aviation places the most importance on lowering the capital costs of aviation to allow small companies and individuals to fly, which requires trade-offs with performance and efficiency. While each is distinct, they all contribute to defense capabilities in different ways.

All three involve aerospace technology and often lead to the discussion of platforms and vehicles. However, each flavor of aviation is also underpinned by complex systems and processes. Militaries need to continuously train, sustain, and innovate in ways that meet their strategic goals. Commercial aircraft manufacturers and commercial airlines are heavily regulated by national safety boards, constrained by the availability of landing slots at key airports and international agreements between nations, and face continuous competition in their markets. General aviation depends on numerous smaller airports and companies to support a myriad of independent actors in ways that do not interfere with military or commercial aviation.

¹ The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of the RAND Corporation or any of the sponsors of its research.

² The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest. RAND's mission is enabled through its core values of quality and objectivity and its commitment to integrity and ethical behavior. RAND subjects its research publications to a robust and exacting quality-assurance process; avoids financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursues transparency through the open publication of research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. This testimony is not a research publication, but witnesses affiliated with RAND routinely draw on relevant research conducted in the organization.

The RAND Corporation has published research on the broad Chinese aerospace industry;³ China's commercial aircraft manufacturing sector;⁴ the U.S.-China military balance, including aerospace capabilities;⁵ and Chinese investment in U.S. aviation.⁶ As of early 2023, in each of the three aviation categories, the United States is ahead of China and competitive with or better than the rest of the world. However, China continues to close the gap with the United States, both overall and with the notable progress of the People's Liberation Army (PLA) in military capabilities and in some specific areas, such as hypersonic weapons. Even with the Chinese Communist Party's (CCP's) direction of large investments in domestic commercial aircraft manufacturing and the occasional purchase of overseas general aviation companies, the People's Republic of China (PRC) continues to lag in commercial and general aviation.

Military Aviation

The PLA aviation capabilities continue to grow. In 2023, more than half of PLA jet fighters are considered modern fourth-generation aircraft, comparable to F-16s, F-15s, and F-18s. The PLA Air Force (PLAAF) has fielded fifth-generation fighters, J-20s, nearly comparable to F-22 and F-35 stealth fighters, in smaller quantities. The PLAAF is also modernizing bomber and airborne early warning and control aircraft, including the anticipated development of a stealth bomber, the H-20. The PLA Navy (PLAN) aviation continues to expand its ability to do carrier operations with two operational aircraft carriers and more under construction. The PLA is also expanding its nuclear strategic forces with both a nuclear-capable bomber platform, H-6N, and new intercontinental ballistic missile fields.⁷

Nonetheless, U.S. global military aviation capabilities still greatly exceed those of the PLA. In 2023, the United States operates hundreds of fifth-generation F-35 stealth fighters with a planned fleet of over 2,000 across the U.S. Air Force, the U.S. Navy, and the U.S. Marine Corps. The F-35 program involves eight nations that partnered in its development and an additional nine nations that are purchasing the aircraft. As of 2023, eight partners and allies of the United States already operate the F-35 in their militaries.⁸ The Air Force is also developing a new stealth

³ Roger Cliff, Chad J. R. Ohlandt, and David Yang, *Ready for Takeoff: China's Advancing Aerospace Industry*, RAND Corporation, MG-1100-UCESRC, 2011, <https://www.rand.org/pubs/monographs/MG1100.html>.

⁴ Keith Crane, Jill E. Luoto, Scott Warren Harold, David Yang, Samuel K. Berkowitz, and Xiao Wang, *The Effectiveness of China's Industrial Policies in Commercial Aviation Manufacturing*, RAND Corporation, RR-245, 2014, https://www.rand.org/pubs/research_reports/RR245.html.

⁵ Eric Heginbotham, Michael Nixon, Forrest E. Morgan, Jacob L. Heim, Jeff Hagen, Sheng Li, Jeffrey Engstrom, Martin C. Libicki, Paul DeLuca, David A. Shlapak, David R. Frelinger, Burgess Laird, Kyle Brady, and Lyle J. Morris, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND Corporation, RR-392-AF, 2015, https://www.rand.org/pubs/research_reports/RR392.html.

⁶ Chad J. R. Ohlandt, Lyle J. Morris, Julia A. Thompson, Arthur Chan, and Andrew Scobell, *Chinese Investment in U.S. Aviation*, RAND Corporation, RR-1755-USCC, 2017, https://www.rand.org/pubs/research_reports/RR1755.html.

⁷ Office of the Secretary of Defense (OSD), *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China*, U.S. Department of Defense, 2022.

⁸ Lockheed Martin, "F-35 Lightning II Program Status and Fast Facts," infographic, March 1, 2023.

bomber, designated the B-21, and the Next Generation Air Dominance (NGAD) fighter to replace eventually the B-2 and F-22, respectively.⁹ The Army is also pursuing the Future Vertical Lift program toward upgrading many of its helicopter capabilities.¹⁰ U.S. naval aviation operates from ten nuclear aircraft carriers and ten conventional amphibious assault ships, including the new *Ford*-class carrier, with the USS *Gerald R. Ford*'s initial deployment in 2022 and the *John F. Kennedy* and *Enterprise* aircraft carriers under construction. However, the United States maintains a global posture, while the CCP's PLA concentrates its military forces in the Pacific, which means that U.S. military overmatch in the region continues to decline. This is true both in the sense that the United States can only deploy a fraction of its aviation forces to that theater and that those forces have to be prepared to operate at much greater distances from U.S. air bases.

In a couple of areas relevant to aviation, China has notable advantages over U.S. military capabilities. As part of a counter-intervention strategy, the PLA has long emphasized a long-range strike missile force under the PLA Rocket Force (PLARF) for force projection and to enable an anti-access and area denial capability. The PLARF has hundreds of ballistic missiles in every class (i.e., short range, medium range, intermediate range, and intercontinental ballistic missiles) and long-range cruise missiles that are both ground and air launched. The PLA continues to expand those capabilities, including testing and deploying hypersonic strike capabilities (e.g., testing a fractional orbital intercontinental hypersonic glide vehicle and deploying the DF-17 medium-range hypersonic glide weapon).¹¹ The PLAAF also fields a significantly larger ground-based integrated air and missile defense system based on surface-to-air missiles (SAMs) than that of the United States. The system is a combination of systems made up of Russian SAMs and indigenous Chinese SAMs and warning radars. Individually, the systems can be very capable, but the PLA has them deployed in a dense pattern of overlapping zones that would be deadly to anything within line of sight of mainland China, protecting key assets and CCP leadership. The same technologies and systems have been placed on PLAN surface vessels, allowing the PLA to extend the capability out into the Pacific Ocean.¹²

In contrast to often having overmatch in aviation capabilities, the United States does not have clear leadership in hypersonic strike or SAM capabilities. The United States has historically relied on bomber and fighter air-to-ground weapons and long-range subsonic cruise missiles for long-range strike capability. Likewise, global projection of airpower by both the Air Force and Navy provides protection to deployed ground and maritime forces. The United States has committed to a third wave of hypersonic systems development with multiple hypersonic programs across the Army, Navy, and Air Force following the initial Cold War hypersonic development wave for intercontinental ballistic missile and space re-entry systems and a second

⁹ John R. Hoehn, *Air Force Next-Generation Air Dominance Program*, Congressional Research Service, June 23, 2022; John R. Hoehn, *Air Force B-21 Raider Long-Range Strike Bomber*, Congressional Research Service, September 22, 2021.

¹⁰ John R. Hoehn, *Army Future Vertical Lift (FVL) Program*, Congressional Research Service, July 13, 2021.

¹¹ OSD, 2022, pp. 64, 83, 98, 149, 167.

¹² OSD, 2022, pp. 53, 61, 82.

wave of development in the 1990s for its national aerospace plane effort.¹³ The Army continues to upgrade Patriot SAM systems; the Missile Defense Agency maintains and develops capabilities for intercepting missile threats to the U.S. homeland, allies, and deployed forces; and the Navy operates surface warfare ships capable of air and missile defense. Because of its primarily global military posture, the United States chooses to remain less dependent on those capabilities than China.

Commercial Aviation

Commercial aviation includes both manufacturers and airlines. Boeing and Airbus continue to dominate the manufacturing of large commercial aircraft, particularly the narrowbody, single-aisle airliner market (e.g., the 737 and A320 series, respectively). Much fewer in number are larger widebody, multi-aisle commercial jets, which are also made by Boeing and Airbus. Regional jets are smaller aircraft that fly shorter ranges and carry fewer passengers. Bombardier of Canada, now Airbus Canada, and Embraer of Brazil are the historical leaders in the regional jet market. Commercial markets also include turboprops with visible propellers and helicopters used for regular passenger or cargo transport, but those are much smaller markets relative to airliners.

For comparison, Boeing and Airbus each assemble roughly 500 narrowbody aircraft annually and one hundred widebody aircraft. The smaller regional jets built annually number less than 200 across all manufacturers. These markets are not exclusive to the companies listed above; most of the markets have multiple competitors trying to expand their limited market share. Because of these limited production numbers, even in the largest narrowbody aircraft market, the global commercial manufacturing markets tend toward duopolies in each aircraft class. The two leading companies achieve the best possible scales of efficiencies, while there are always competitors looking for an opportunity to break in.

Much of commercial aviation revenue is generated by the airlines that operate the aircraft. In contrast to naturally occurring global manufacturing duopolies, the airline industry is structured around state regulation. Every nation controls its sovereign airspace and decides what aircraft are safe to fly and land there, as well as what routes are available. Commercial airports are also public infrastructure with limited numbers of gates and landing slots. As a result, most nations strive to support multiple major domestic carriers for competition and often have multiple smaller low-cost carriers trying to carve out market share in the larger-volume routes. International carriers are generally constrained by agreements between nations where routes and landing spots are typically made available on a roughly equal basis. There are plenty of exceptions to these generalizations, but they are representative of the global airline markets.

In this context, China is roughly a fifth of the global economy and the world's population, which translates to 20 percent of the global aviation market share. This gives the PRC purview over something like a fifth of the future commercial airline market but no historical presence in commercial aircraft manufacturing. China's aerospace sector is primarily state-owned enterprises

¹³ Michael E. White, "U.S. and Adversary Hypersonic Programs," statement prepared for the Strategic Forces Subcommittee of the House Armed Services Committee, prepublication version, March 10, 2023.

that are controlled by the CCP, supervised by the PRC, and resourced by the Chinese banking sector. Combined with PRC state plans to develop the aerospace sector and “Made in China” policies, the PRC established the Commercial Aircraft Corporation of China (COMAC) to compete in the global commercial aircraft manufacturing market. Founded in 2008, it is not a public company but a joint venture of two PRC state-administered investment funds and a number of large Chinese state-owned enterprises.¹⁴ COMAC’s efforts are detailed in multiple RAND studies, which I will update in this testimony.¹⁵

COMAC started with the development of a regional jet, ARJ21, to gain experience and to learn how to navigate a system of commercial safety certification. The Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) are each global leaders in aviation safety oversight and certification and both establish global best practices. They typically recognize each other’s certifications and most other national aviation safety organizations do as well. Starting with its first test flight in 2008 and initial efforts to work with the FAA and EASA, the Civil Aviation Administration of China (CAAC) certified the ARJ21 in 2014. In 2023, a little over one hundred ARJ21s are in commercial service. The first international delivery of an ARJ21 was to Indonesia in 2022. COMAC delivered a record 30-plus ARJ21 aircraft in 2022.¹⁶

COMAC has also entered the more lucrative narrowbody market with the C919. In 2022, the C919 received CAAC safety and production certification, and COMAC delivered its first commercial aircraft to China Eastern Airlines.¹⁷ It anticipates commercial operation certification and increased production of the C919 with orders from several Chinese airlines.

Lastly, the China-Russia Commercial Aircraft International Corporation (CRAIC), based in Shanghai, is a joint venture between Russia’s United Aircraft Corporation and COMAC to develop a larger widebody aircraft, the C929. Starting in the early 2020s, after ongoing discussions begun in the previous decade, CRAIC hopes for its first flight by 2030. Sanctions related to the Russian invasion of Ukraine, which may restrict access to Western aerospace supply chains, have complicated this effort.

As of early 2023, the PRC and COMAC have not yet captured a significant share of the global commercial market. Nonetheless, COMAC has made significant progress toward that goal. It has a regional jet and a narrowbody commercial airliner safety certified in China. It has been producing and delivering regional jets for a few years to PRC airlines. These airlines are operating ARJ21 aircraft and learning how to efficiently maintain them. Following the 2020 aviation safety agreement between EASA and CAAC, the path for safety certification of COMAC aircraft in Europe is looking more promising.

¹⁴ See Commercial Aircraft Corporation of China, “Introduction,” webpage, undated, <http://english.comac.cc/aboutus/introduction/>.

¹⁵ See Ohlandt et al., 2017; Crane et al., 2014; and Cliff, Ohlandt, and Yang, 2011.

¹⁶ “COMAC Delivers the 100th ARJ21 Aircraft, Showing Homegrown Regional Jetliner Entering Mass Production Period,” *Global Times*, December 29, 2022.

¹⁷ Zhu Wenqian, “C919 Receives CAAC Production Certificate in Milestone for Homegrown Aviation,” *China Daily*, November 29, 2022; Tu Lei and Shen Weiduo, “Domestically Developed First C919 Jet Delivered to China Eastern, ‘Marking a Start in Journey Toward Mass Production,’” *Global Times*, December 9, 2022.

COMAC's supply chains for the ARJ21 and C919 are dependent on Western companies for engines, control systems, and other components. So, while every COMAC aircraft delivery to the Chinese domestic market is a loss for Embraer, Airbus, or Boeing, other U.S. and European aerospace companies in the COMAC supply chain do benefit.

It is important to differentiate between military and commercial aviation technology and capabilities. However, commercial aviation can contribute to defense capabilities. First, commercial aviation can be used as a substitute for military airlift. If the PLA wanted to move people and cargo large distances quickly, it could leverage its domestic airlines and their aircraft to do so. Today, those aircraft are dependent on Boeing and Airbus supply chains. Second, a successful commercial aviation industry can provide industrial capacity that can be redirected to military aviation. The PRC has already leveraged its successful shipbuilding industry to expand the PLAN rapidly.

General Aviation

Any aviation not attributed to military or commercial aviation falls into the category of general aviation. General aviation concerns the individual aviator and private ownership or operation of aircraft for noncommercial purposes. It covers a wide variety of smaller aircraft from simple propeller airplanes to small helicopters to hobbyist drones. On the upper end, business jets for personal or corporate travel are part of general aviation. While quite diverse in nature, general aviation has the common goal of making aviation affordable to the individual private entity. It generally does not involve technology necessary for military performance or commercial efficiency and safety. As such, general aviation usually does not have national security or national economic implications.

It is worth discussing here for two reasons. First, many attempts at purchasing U.S. or other foreign aerospace companies by Chinese entities revolve around general aviation companies because their technology and revenues are less significant compared with military or commercial aviation endeavors in terms of national security or economic implications. Additionally, because PRC policy advocates for the development of aerospace industry in China, the transfer of funds outside China is more likely to be approved given PRC capital controls. While general aviation companies do not, as a rule, have national security or economic significance, there are cases with negative consequences where North American jobs are moved to China following the acquisition or control of overseas general aviation companies assumed by the Chinese entities that are hard to hold accountable in U.S. courts, which raise concerns.¹⁸ For example, in 2011, such concerns were raised with China's Aviation Industry Corporation of China's (AVIC's) acquisition of Cirrus Aircraft, a manufacturer of general aviation aircraft, including single-engine planes and jets, that continues to be based in Duluth, Minnesota, which as of 2018 has established some manufacturing and assembly in Zhuhai, China.¹⁹

¹⁸ Ohlandt et al., 2017.

¹⁹ "Buyers Collect 1st Made-in-China/Zhuhai Cirrus Aircraft," City of Zhuhai, November 12, 2018, http://www.cityofzhuhai.com/2018-11/12/c_290836.htm.

Second, the growing personal drone market and evolving commercial use of drones fall under general aviation. The largest maker of commercial drones, Da Jiang Innovations (DJI), is in China.²⁰ While DJI does not market military-grade drones, their products are often conflated with such. One of DJI's specialties is drone-based video that can be used to monitor local populations for law enforcement purposes. The 2022 Russian invasion of Ukraine has also further demonstrated the utility of smaller drones for tactical targeting in ground warfare. Business concepts around package delivery by aviation drones are rapidly evolving with the technology and government regulation.

General aviation typically concerns large numbers of independent individuals and entities dispersed geographically using aviation and supported by similarly dispersed small airports and businesses. The United States has a general aviation tradition that dates back to the origins of human flight. It is worth noting that little of this is true for China. The PRC's population is mostly located in dense urban areas. The PLA controls the national airspace. There is no significant historical tradition of general aviation in China. Even while some Chinese elite may desire private jets or planes for convenience, the occasional CCP campaign against waste and privilege tempers that desire. The PRC system run by the CCP is not well aligned with the concept of general aviation that involves numerous independent actors.

Findings

In each of the three categories of aviation—military, commercial, and general—the United States leads in aviation capability and technology. However, the CCP-led PLA military and PRC government are actively trying to match U.S. and European aviation capabilities. As of early 2023, the PRC continues to make steady progress in closing the aviation technology gap. The PLA has military aviation capabilities, including stealth aircraft, airborne early warning and control, and naval aircraft carrier forces, that are second only to those of the United States, and the PLA combines such capabilities with long-range missile forces and ground-based SAMs that are second to none. PRC state-owned enterprises have spent 15 years and unknown billions of dollars building COMAC to compete with Airbus and Boeing in commercial aircraft, which in 2022 was just starting to deliver narrowbody commercial aircraft to China's domestic airlines. China's DJI exports more small drones than any manufacturer in the world, and AVIC owns U.S.-based Cirrus Aircraft, which builds light aircraft for the general aviation market.

When Congress considers potential policy actions for maintaining U.S. competitive advantages in aviation, it should take into account the three categories of aviation discussed here. If Congress wants the United States to stay ahead of China in military aviation capabilities, it could continue investing in advanced capabilities, such as the B-21, NGAD, unmanned aerial vehicles, vertical lift, hypersonic weapons, and numerous other aviation capabilities, while protecting the technology unique to those capabilities, such as stealth materials, advanced radars, and high-performance super-cruise jet engines. None of this is new in terms of policy, but maintaining a U.S. advantage in military aviation capabilities requires continual attention to

²⁰ Ness Anwar, "World's Largest Drone Maker Is Unfazed—Even If It's Blacklisted by the U.S.," CNBC, February 7, 2023.

resourcing U.S. efforts while providing oversight of the mechanisms that protect U.S. military technologies, such as cybersecurity, counterintelligence, and Committee on Foreign Investment in the United States operations.

Competing in commercial aviation requires a more nuanced policy. Boeing and its partners benefit from high barriers to entry into its market, which result in a natural duopoly with Airbus. However, Congress cannot ignore that the CCP and PRC are investing billions of dollars toward displacing either Boeing or Airbus, even though, at the same time, U.S. suppliers to COMAC benefit from Chinese investments and COMAC sales. The United States and Europe have long disagreed on what constitutes acceptable government support of their aviation industries, which has led to long-running World Trade Organization disputes between Boeing and Airbus.²¹ Rather than focus on short-term impediments to Chinese aviation by restricting non-military aviation technology or by slowing aviation safety approvals, the United States and Europe could agree to a common set of principles for investing in commercial aviation and then together hold China to those standards. If Congress wants to promote a level playing field in commercial aviation on which U.S. companies can continue to win, it could incentivize the U.S. government and industry to adopt a common understanding or agreement with U.S. allies and partners in aviation, particularly Europe.

Lastly, general aviation has less significant economic and national security implications. With many different actors working on a smaller scale, general aviation also has lower barriers to entry for Chinese companies and greater room for competitive responses from U.S. entities. If Congress wants to maintain U.S. competitiveness in general aviation, it could continue to support a healthy general aviation community of small business, small airports, and aviation regulation. For example, the growth of drones and personal air vehicles for short-range transport has created new challenges; Congress could support the efforts of the FAA and the National Aeronautics and Space Administration to address them.

²¹ See Crane et al., 2014.