PROJECT 2049 INSTITUTE

Futuregram 09-002:
China's Commercial Aviation Sector Looks to the Future

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Gleaming with confidence in the wake of its success in space, China is emerging as a global commercial aviation player. Its ambitions in commercial aviation are one facet of a broader vision to develop a modern, world-class, and integrated national air and surface transportation system. Over the decades, China's economy has expanded despite an underdeveloped infrastructure. However, authorities in Beijing are becoming increasingly aware that further sustainment of its economic development requires an efficient system to move goods and people across the land mass of China.

A critical component of Beijing's vision is the design, development, and production of internationally-certified commercial aircraft, including a regional airliner dubbed the ARJ-21 and the C-919 jumbo jet. Under the guidance of a transplanted cadre of leaders with a proven track record in the space industry, success in the aviation sector would signify the emergence of China as an advanced global industrial power. Success also would indicate that long standing weaknesses in industrial systems engineering have been addressed. The entrance of a Chinese competitor could threaten challenge the traditional dominance over the global aviation market that American and European companies have enjoyed for decades. However, profitability and dominance in the international aviation market may be less important than the long-standing desire to be judged as an equal among the world's most advanced industries.

Pudong International Airport

China's Aviation Demands

China is viewed as one of the top two aviation markets in the world. Around the world, about 2 billion flyers ply the skies each year for business and leisure travel. With the number of global travelers growing at 5% a year, airlines are expected to spend U.S. $2.8 trillion to acquire 28,600 new commercial aircraft over the next 20 years. About 75% of the global demand for civilian aircraft is for jumbo jets, defined as having more than 150 seats. [1]

In light of the growing global demand for aircraft, China's expanding requirements are most significant. The number of passengers traveling by air within China has more than doubled since 2000. As of June 2006, China-based airlines operated 913 aircraft, a number that should increase to 1500 by the end of the end of next year. Over the next 20 years, Chinese airlines are expected to spend U.S. $340 billion on 3,400 new airplanes, of which 1400 are large-sized "jumbo jet" aircraft.[2]

While there is a general trend toward the less expensive ocean shipping, global air cargo traffic is expected to triple over the next 20 years. China should continue to serve as a major manufacturing base for Taiwanese and other global industries' high technology products, which make up 20% of all air cargo. Domestic China and intra-Asia cargo traffic, with Shanghai serving as the hub for much of the region's transportation network, is expected to expand by 9.9 and 8.1 percent respectively. Chinese air carriers will add about 300 freighter airplanes by 2026.[3]

To meet its growing demands for air travel, China is planning to expand its domestic aviation infrastructure. The country currently has 147 commercial airports, with only 26 able to accommodate B-747 sized aircraft. Its airport density is one of the world's lowest (1.5 airports per 100,000 kilometers, as compared to 6.4 for the U.S., 23.3 for Japan, and 21.7 for France).

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However, with an average 17% annual growth in the number of passengers between 1996 and 2006 (16.8% for cargo), authorities in Beijing have identified a need for additional airports. To handle its anticipated growth in air traffic, China is allegedly planning construction of 50 new airports and conversion of 12 military airbases to dual use fields.[44]

One of the bottlenecks in China's expanding demand for air travel is the People's Liberation Army (PLA) control over the nation's skies. With the PLA controlling over 80% the airspace over China, the central government has also identified the need to open additional airspace open for commercial use and to ease air traffic congestion. The "golden triangle" air corridors linking Beijing, Shanghai, and Guangzhou are reportedly near saturation.[5]

China Commercial Aircraft Corporation

In order to partially satisfy its own domestic requirements, Beijing's State Council in May 2008 directed the formation of a new entity responsible for design, development, and manufacturing of commercial aircraft. The China Commercial Aircraft Company's (COMAC; 中国商用飞机有限责任公司) mission is to design, develop, manufacture, and maintain regional and large bodied commercial aircraft and helicopters, as well as engines and other airborne systems. The key metric of success will be COMAC's ability to gain international airworthiness certification, which would require the cooperation of Boeing and Airbus, and the U.S. Federal Aviation Administration (FAA).

The State Council's Ministry of Science and Technology commissioned initial feasibility studies into the large aircraft program in 2003, led by the Beijing University of Aeronautics. The large aircraft program was one of sixteen national development priorities outlined in the National Program for Long-and-Medium-Term Scientific and Technological Development (2006-2020). The National People's Congress approved the plan for formation of the company in February 2007, which was followed by formation of a preparatory committee under the direction of the Commission of Science, Technology, and Industry for National Defense (COSTIND).[6] Much of the debate surrounded the basing of the program, subordination of COMAC to the Aviation Industry Corporation (AVIC), relative prioritization of commercial aviation over military, and the extent of foreign involvement.[7]

The end result was that Shanghai, with its interests in prioritization of civil industry and foreign cooperation, won the day. As testament to its national priority, COMAC is a state-owned enterprise that reports directly to the State Council, rather than AVIC. The largest stakeholder, with a 31.6% stake in the venture's original U.S. $2.7 billion (RMB 19 billion) capitalization, is the State Council's Assets Supervision and Administration Commission (SASAC). The Shanghai municipal government via the Guosheng Group (國盛集團) has a 25% stake, with about a U.S. $700 million investment in the venture. The third major stakeholder is AVIC, which is said to have just under a 25% share in the business through the transfer of its AVIC Commercial Aircraft Co (ACAC), Shanghai Aircraft Manufacturing Factory, and the Shanghai branch of First Aircraft Institute.[8] Other stakeholders holding about 5% of the venture ($150 million) include three state-owned enterprises — Baosteel Group Corp., the Aluminum Corporation of China and Sinochem Corp. The Chinese government has been open to foreign investment.[9]

Spinning Off Success: From Space and Missiles to Aviation

A reflection of the importance that China's senior political leadership places on China's commercial aviation sector is the assignment of China's best and brightest industry leaders to senior leadership positions. Leading COMAC is a group of relatively young engineers with roots in China's space and missile industry, the most advanced among the country's defense enterprises. With a background in launch vehicle design and having played a leading role in China's successful manned space

program, Zhang Qingwei (张庆伟) was appointed as COMAC Chairman. In his forties, Zhang represents a younger generation of aerospace engineers who Beijing hopes could turn around China's lagging aviation industry. The State Council appointed Zhang as COMAC Chairman following his tenure as COSTIND Director and Director, China Aerospace S&T Corporation (CASC).[10]

Zhang Qingwei

Accompanying Zhang Qingwei were other senior managers from the space and missile industry. With roots in CASC's Shanghai base, COMAC General Manager Jin Zhuanglong (金壮龙) served as under Zhang as CASC Deputy Director and COSTIND Deputy Director. Another COMAC Deputy Director, He Dongfeng (贺东风), managed CASC China Academy of Launch Technology's 211 Factory before becoming CASC Deputy Director. His last position prior to COMAC was head of the Sichuan-based space industry.

Boeing, Airbus, and COMAC

With its expected demand for commercial aircraft and a government procurement law that favors homemade products, China's interest in developing and manufacturing an indigenous large passenger aircraft should be no surprise. Government interest in an indigenous commercial aircraft began in 1970 when its aviation industry began R&D on the 170-seat, 110 ton Yun-10 (Y-10), comparable to the Boeing 707. Two prototypes were fielded, and one successfully tested in 1980. However, the program was terminated in 1983 due to, at least in part, lack of interest among China's commercial airlines and reduction in central government funding.

After termination of the program, the central government developed a three phased plan to gain domestic commercial aircraft manufacturing capability. First, the aviation industry would master aircraft assembly for foreign enterprises, such as the MD-80 for McDonnell Douglas. The next step would be design and development a small regional jet, and followed by a large passenger aircraft. In 1985, McDonnell Douglas was contracted for assembly of 35 MD-80 series aircraft in Shanghai. A follow-on deal was concluded in 1992 for co-production of 40 more MD-80/90 aircraft, although McDonnell's merger with Boeing resulted in a cancellation of the program.

Airbus and Boeing, as well as Russia's aviation industry, have long and deep relationships in China. Both Boeing and Airbus have outsourced much of their work to China, presumably in part to offset the sales of commercial aircraft to meet China's growing demand. Much of Boeing's 737 has been manufactured in China, including horizontal stabilizers manufactured in Shanghai, vertical fins in Xian, and doors in Chengdu. Sections with major composite requirements, such as the tail cone, wing panels, and fairings, are manufactured in Tianjin. Other parts are produced in Langfang and Shenyang. In June 2005, Boeing outsourced work on composite structures for the Boeing 787 to its facility in Tianjin. Boeing also uses China-based industry to convert existing 747s to freighters for use in China, and has outsourced work on flaps, ailerons and spoilers for Boeing 747-8 airplanes.[11]

Airbus has followed a similar model, but has gone a step further by establishing an entire assembly operation in China. A June 2007 agreement calls for assembly of the A320 in Tianjin, with work scheduled to start in 2009. With the exception of the wing box that is manufactured in Xian, all the major parts for the aircraft are shipped from Hamburg to Tianjin for final assembly. A total of 300 A320 planes are to be produced by 2016, all to be purchased by China. Airbus also has agreed to establish a joint venture manufacturing center in Harbin in 2009 for producing composite parts for the A350 XWB.[12]

Much of China's experience in partnering with foreign aviation enterprises stems from a cozy defense industrial relationship with Russia that started in 1992. However, a spate of business dealings gone bad are said to have spoiled the relationship to some extent. Besides acquisition of

Russian airframes, China's aviation industry procured numerous Russian sub-systems for integration into its own aircraft programs, including engines and radars installed onto most fighters in the PLAAF and PLAN fleet.

The ARJ-21

First announced in 2002, the Advanced Regional Jet for the 21st Century (ARJ-21) is a stepping stone toward the State Council's more ambitious vision. The ARJ-21 will be the country's first indigenously designed, developed, and manufactured passenger plane. The ARJ-21 is entering a very competitive market, with Bombardier and Brazil's Embraer as the established players in regional jets and turboprops. However, along with the ARJ-21, Japan's Mitsubishi Heavy Industries is introducing a fuel-efficient plane, called the Mitsubishi Regional Jet.

As a general rule, a regional jet is designed to transport passengers on flights of less than two hours in duration, to destinations less than 1,800 kilometers away, and where passengers are insufficient to fill up a large aircraft, or where a runway may be too short for a larger aircraft. Carrying between 70-90 passengers, the ARJ-21's range is around 2,225 kilometers (about 1,383 miles). Resembling a modified version of the MD-80, the aircraft is outfitted with twin fuselage-mounted General Electric (GE) CF34-10A engines. After a two year delay, the ARJ-21 made its maiden flight in Shanghai in November 2008 and flight testing will continue out through 2009. Assuming FAA airworthiness certification by early 2010, initial deliveries are expected by mid-2010.[13]

The new airframe is supposed to reduce ticket prices inside China by as much as 10%. Cargo and business jet variants are expected as well. At least 208 of the aircraft have been ordered by domestic airlines, and General Electric has orders for as many as 25 of the aircraft. Total global sales over the next 20 years are projected to be 850 aircraft, which for the Ohio-based GE Aviation represents a major source of revenue. It's worth noting that one potential domestic competitor for regional air travel within China could be the country's new network of high speed rail lines, a challenge that Taiwan's airline industry has faced.

The ARJ-21 program also marks the first time that Chinese industry has managed a sophisticated international supply chain. China has lots of experience in serving as suppliers of components and sub-assemblies to Boeing and Airbus. However, in this case China will be tapping into a similar global supply chain network used by Airbus and Boeing. That means that China will be creating stakeholders who will be loyal to and willing to share risk with COMAC. The ARJ-21 program involves 15-20 foreign suppliers, and the C-919 program is expected to follow suit.[14]

The C-919

China's experience with developing and manufacturing the ARJ-21 program and its assembly work for the Airbus 320 sets the stage for its large-bodied aircraft program. Designated as the C-919, COMAC is planning to manufacture up to 3000 of the aircraft, with a primary eye toward the domestic market.[15] All in all, a total of 47 different entities in China and abroad are said to be in the supply chain. Follow-on variants are referred to as the C-929 and C-939.

Source: Xinhua, April 6, 2007

Manufacturing capacity should be 150 a year and a total of 3000 aircraft are expected to be produced. Development, general assembly and manufacturing, and customer service centers are expected to be formed. The assembly and manufacturing center are said to be growing from the current 2000 employees to around 20,000 as the programs enter full rate production of 150 jumbo jet and 50 regional jets a year. Technology parks in Kunshan and elsewhere in the greater Shanghai area have

begun advocating a role in the aircraft supply chain.

The preliminary design is said to have been completed, and there are five phases: preliminary development, engineering development, detailed design, comprehensive testing, and airworthiness certification. Initial flight tests are projected for 2014. The aircraft is expected to enter the fleets of domestic airlines during the 13th Five Year Plan beginning in 2016.[16]

Designers of the jumbo plane include Wu Guanghui (吳光輝) and also AVIC's S&T Department head Zhang Hongbiao. Before starting his Presidency in AVIC II, Zhang served as Vice Minister of the Commission of Science, Technology and Industries for National defense (COSTIND) between 1998 and 2004, taking responsibility for R&D, production and development in the sectors of aviation, ship building, civilian products development and structure reform of defense industries and research institutions.

China's aspirations include the development of advanced engines. Over the years, China's aviation industry has gradually accumulated expertise in engine development and manufacturing. However, the experience has been almost exclusively associated with military programs, such as the Russian AL-31 engine used on the Su-27 and the Chinese-built WS10A engine that powers the J-10 fighter.

In a move toward civilianization of its aviation industry, the State Council directed the formation of the AVIC Commercial Aircraft Engine Co (ACAE) in January 2009. Based in Shanghai, ACAE would presumably take the lead on engine development or assembly for COMAC aircraft, and remedy what has been a long standing weakness in China's aviation industry. AVIC is said to hold a 40% stake in the venture, with the Shanghai Electric Group and Shanghai Guoshang, the city government's investment arm, hold 15 percent each. Foreign enterprises have been encouraged to invest in the remaining assets.[17]

The C-919 program is expected to rely on foreign engines in the initial phase, but has set its sights on indigenous engines for the C-929 and C-939 variants. The general trend in engine technology is development of light, high-temperature composite materials to reduce weight, fuel consumption, and direct operating costs. Boeing has expressed interest in expanding its composite material manufacturing facility in Tianjin in part with an eye to supplying COMAC.[18]

Taiwan and China's Aviation Industry

Not to be left out, Taiwan's Aerospace Industrial Development Corp (AIDC) also has expressed interest in entering into China's aviation market. Buoyed by the company's 18% growth rate in 2007 and 10% revenue growth in 2008, AIDC has expressed interest in investing in mainland China for manufacturing of components and sub-assemblies for COMAC commercial airliners, outsourcing of research and development to partners in China, as well as sourcing of materials for manufacturing in Taichung.

Under the "Bridging Plan" (搭橋計畫), Taiwan's Executive Yuan has been evaluating a relaxation of restrictions that had been placed on state-owned companies to invest on the Mainland. Under the plan, China Petroleum Company, Taiwan Sugar, and AIDC will be among the first state-owned enterprises to be allowed to invest in the mainland. The Ministry of Economic Affairs had planned on hosting a delegation from COMAC, the Air China Group, and Shanghai Air to evaluated possible areas of cooperation. AIDC may team with its own suppliers, such as Topkey, Chenfull International, and Chaheng Precision, to enter the China aviation market.[19]

Conclusion

The successful development of an internationally-certified indigenous commercial aircraft would signify the emergence of China as an advanced global industrial power. Similar to major developmental military and space systems, commercial aircraft are complex systems consisting of sophisticated materials, components, sub-systems, and other parts. However, unlike military

systems, commercial aircraft must meet the highest international quality control standards since safety is of utmost importance.

To earn the right to stand with and compete against global aerospace powerhouses such as Boeing and Airbus would satisfy a symbolic aspiration that Chinese leaders have sought for decades. Whether or not Chinese commercial aviation products would win against their western competitors, or if COMAC will be profitable, is not particularly relevant. What is important is being judged as qualified to compete.

The systems engineering skills that would be developed to field an internationally-certified commercial aircraft could replicate themselves in defense programs, such as an aircraft carrier or future military aviation projects. Systems engineering has long been viewed as one of the key weaknesses of China's defense industry. However, one should be cautious in assuming that success in a systems engineering environment that rewards innovation, is relatively transparent, influenced by market forces, and open to international suppliers could be matched in equally complex military programs bounded by conservatism and secrecy. The need for a more efficient and expanded national air transportation infrastructure as a means to ensure sustained economic development could compel the PLA to further loosen its hold on the skies over China.

Finally, the entrance of a Chinese competitor could threaten the traditional dominance over the global aviation market that American and European companies have enjoyed for decades. However, from the unbiased air traveler's perspective, another player in the commercial aviation field could offer future consumers more choice and perhaps incentivize the incumbent players to work harder develop more innovative solutions for 21st century air travel.

[1] *Current Market Outlook*, 2008-2027, Boeing Corporation, at www.boeing.com/commercial/cmo/index.html.

[2] *Current Market Outlook*, 2008-2027, Boeing Corporation, www.boeing.com/commercial/cmo/index.html. Hou Lei, "First Jumbo Jet to Take Off in 2014," China Daily, March 13, 2009, internet version.

[3] For an excellent survey of global air cargo trends, see Jan Maurits de Jonge, "No Break In the Storm: 2009 Will Be A Grim Year For The Air Cargo Industry," Air Cargo World Online, December 2008, at http://www.aircargoworld.com/features/1208_1.htm. The author is an analyst with Seabury Aviation & Aerospace. Also see Boeing's website.

[4] World Air Cargo Forecast 2008-2009, http://www.boeing.com/commercial/cargo/01_06.html.

[5] Dorothy Reimold, Acting Assistant Administrator for International Aviation, Federal Aviation Administration, in presentation at the Center for Strategic and International Studies (CSIS), August 8, 2008, at http://www.csis.org/component/option,com_csis_events/task,view/id,1753/. Also see Bruce Stanley, "China's Congested Skies," *Wall Street Journal*, February 16, 2007.

[6] In March 2008, COSTIND was subordinated to the Ministry of Industry and Information Technology (MIIT) and renamed as the State Administration for Science, Technology and Industry for National Defense (SASTIND).

[7] See Liu Chen, "Background on the Large Aircraft Policy," (*Dafeiji zhanbei juece beihou*), *Shanghai Economics* (*Shanghai jingji*), June 2008, pp. 16-18. Shanghai Economic Commission member Jiang Shangzhou, Vice Premier Zeng Peiyan, and former Science and Technology Minister Song Jian are highlighted as major driving forces behind the bureaucratic success in launching the program in its current form.

[8] AVIC is a conglomeration of aircraft design and manufacturing bases located throughout China. Between July 1999 and October 2008, it was split into separate organizations – AVIC I and AVIC II. AVIC I had focused on larger civilian and military aircraft, including medium range commercial aircraft, fighters, and bombers. Its primary centers include the Chengdu Aircraft Industry Corporation, Shenyang Aircraft Industry Corporation, Xian Aircraft Industry Corporation, Guizhou Aircraft Industry Corporation, and the Shanghai Aviation Industry Corporation. AVIC II designed and developed smaller aircraft and helicopters.

[9] Liu Chen, pp. 16-18.

[10] For a good overview of Zhang's stellar rise in the space and missile industry, see Kevin Pollpeter, "The Stars of China's Space Program: The Rise of a 'Space Gang'?," Jamestown Foundation *China Brief*, Vol. 7, Issue 17, September 19, 2007.

[11] See: "Boeing in China," June 2008, at

http://www.boeing.com/companyoffices/aboutus/boechina.html.

[12] The wing box, which is the main part of the wing, minus the flaps and internal electronics, is one of the A320's most sophisticated parts. Lu Haoting, "Airbus, Harbin plane parts maker form joint venture," China Daily, July 17, 2007, at http://www.chinadaily.com.cn/bizchina/2008-07/17/content_6854310.htm.

[13] The FAA opened an office in Shanghai in 2007 to support the certification process.

[14] International suppliers include Ukraine's Antonov (supercritical wing design), Alcoa (advanced aluminum and other materials), Honeywell (flight control systems), Rockwell Collins (integrated avionics), Hamilton Sundstrand (auxiliary power units and airborne power supplies), GE (engines), Dunlop (tires), LISI Aerospace (fasteners), and Goodrich (lighting systems among other things). With wing structure work carried out in Xian, the Shanghai Aircraft Manufacturing Factory is responsible for final assembly.

[15] The C represents China, and also the first letter of the abbreviation for Commercial Aircraft Corporation of China, Ltd. The first "9" in the name implies "forever" in Chinese culture, while "19" means the first jumbo jet produced by China will have 190 seats.

[16] Zuo Lin, "Domestic C919 Large Aircraft Program to Use 3000 Boeing 737 Engines" (Guochan C919 dafeiji jiang chan 3000jia fadongji youyu boyin737**),** http://www.sina.com.cn, 2009年04月30日, at http://mil.news.sina.com.cn/2009-04-30/1001550472.html.

[17] "China Establishes Firm To Produce Jet Engines for Commercial Aircraft," *Xinhua News Service*, January 19, 2009, in OSC CPP20090119968079, 0437 GMT 19 Jan 09.

[18] Lu Haoting , "Boeing Ups Tianjin Project Capacity," *China Daily Online*, 20 Nov 08, OSC CPP20081120968039; and Wendell Minnick, "Feng Shih-Kuan: AIDC Chairman and CEO," *Defense News*, August 18, 2008, http://www.defensenews.com/story.php?i=3678988.

[19] Song Chien-sheng, "AIDC Plans Cooperation with China to Build Airplanes," *Ching-Chi Jih-Pao*, December 29, 2008, in OSC CPP20090105669001.

About the Project 2049 Institute

The Project 2049 Institute, established in January 2008, seeks to guide decision makers toward a more secure Asia by the century's mid-point. The organization fills a gap in the public policy realm through forward-looking, region-specific research on alternative security and policy solutions. Its interdisciplinary approach draws on rigorous analysis of socioeconomic, governance, military, environmental, technological and political trends, and input from key players in the region, with an eye toward educating the public and informing policy debate.

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