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Summary

The stealthy online unveiling of China's next generation fighter aircraft, dubbed the J-20, represents an important marker in the accelerating development of China's defense science, technology, and innovation capabilities. Although it will likely take another 5–10 years before the aircraft is ready for serial production and operational service, its unofficial public debut serves notice of China's intent to become a world-class military power within the next decade.

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THE STRATEGIC SIGNIFICANCE OF THE J-20 PROGRAM FOR CHINA'S MILITARY TECHNOLOGICAL STANDING

The Chinese military aviation industry has made impressive strides over the past 15 years in narrowing its technological gap with the world's advanced aviation powers. In the mid-1990s, China was struggling to produce third-generation, 1970s-era combat aircraft that were 20–30 years behind their global counterparts. After major structural reforms and considerable assistance from Russia, China is now able to field fighter aircraft such as the Chengdu J-10 and Shenyang J-11 that are only 10–15 years behind the most advanced Western models. The J-20 will reduce this gap even further.

China's military aviation industry is now a prospective candidate to join an exclusive group of countries able to indigenously develop a stealth aircraft. The only established member of this elite set is the United States, which has successfully developed and fielded a number of stealth aircraft over the past two decades. Russia is in the early stages of testing its first stealth aircraft, named the T-50. Other advanced military aviation powers such as the United Kingdom, France, and Sweden that potentially have the technological capabilities have opted not to develop stealth programs because of the huge costs, uncertain sales prospects, and their considerable investment in more traditional, non-stealth fighter aircraft projects.

Besides China, no other country in the Asia-Pacific region has the technological and industrial capabilities to pursue a stealth fighter program. Japan has built a scaled mock-up of a stealth fighter, but it has yet to make any significant investments in conducting serious research and development in this area. It most likely will seek instead to purchase the F-35 stealth fighter from the United States. India signed an agreement with Russia in December 2010 to acquire fifth-generation fighter aircraft based upon the T-50. Other countries, especially Taiwan, may now have to reconsider their long-term plans for the modernization of their air forces in anticipation of China's arrival into the stealth fighter club before the end of this decade.

DOES THE J-20 PROGRAM REPRESENT A TECHNOLOGICAL BREAKTHROUGH?

While web images of the J-20 offer some tantalizing glimpses of its design profile, there are critical knowledge gaps that make it difficult to determine whether the aircraft represents an incremental or breakthrough technological innovation or something in between. One big question concerns how stealthy the aircraft is. This refers to its ability to minimize its radar cross-section through its architecture and radar-absorbent composite materials. Another issue concerns the sophistication and integration of avionics capabilities. The latest generations of state-of-the-art Western fighter aircraft are now being equipped with Active Electronically Scanned Array radar and advanced sensors. There are few indications that the Chinese defense industry has been able to master this technology. Additionally, stealth aircraft are supposed to be exceptionally maneuverable and able to cruise at high speeds because of high performance vectoring engines.

If the J-20 were able to meet all or even some of these requirements, it would be a remarkable breakthrough technological accomplishment. While the Chinese aviation industry has made some important progress in the fields of composite materials, avionics and sensors, design processes, and propulsion technology over the past decade, these technological capabilities and standards remain considerably short of world-class standards. For example, the Chinese aero-engine sector has yet to begin serial production of its own high-performance turbofan engines such as the WS-10 even though it claims to have mastered development a few years ago.

To address these weaknesses in its research, development, and engineering capabilities, China has turned to foreign sources, especially Russia, for critical assistance. Without reliable Chinese aero-engines, China has had to import Russian engines to equip its mainstay J-10 and J-11 fighter fleet. Of particular relevance for the J-20 program was China's request to Russia for Type 117S aero-engines during annual defense technology cooperation talks between the two countries last year.

These engines are being used on Russia's T-50 aircraft.

Reverse engineering is another technique extensively employed by the Chinese aviation industry to overcome technological hurdles and shorten development times. This includes cooperative deals with Russia in which the Chinese purchased license production rights to produce Su-27 fighter aircraft in the late 1990s and unauthorized reverse engineering of that aircraft at the same time. Having access to foreign technologies and knowledge will allow China to mitigate the considerable developmental risks posed by an ambitious but technologically immature aviation industry.

THE CURRENT STATE OF CHINA'S AVIATION INDUSTRY

After sixty years of struggle and stagnation, the Chinese aircraft industry has been experiencing a renaissance over the past decade. The industry is reaping record profits, receiving plentiful flows of orders, developing and producing new generations of advanced aircraft, and forging business and technology ties with some of the world's leading aircraft and aircraft component firms.

This is a far cry from the end of the 1990s when the industry was a loss-making relic of the bygone central planning era. The aviation industry, along with the rest of the defense economy, was severely impacted by the introduction of economic reforms in the late 1970s. Heavy cuts in defense spending and a sharp decline in support for the state sector led to a prolonged downturn during the 1980s and 1990s. The aviation industry's problems were exacerbated by the unwillingness of conservative defense industrial leaders to implement meaningful reforms to reduce enormous waste, inefficiency, and widespread obsolescence.

The inability of the aviation and defense industries to meet the modernization needs of the People's Liberation Army (PLA) became a critical national security concern from the mid-1990s on as tensions intensified in the Taiwan Strait. In the late 1990s, the central authorities intervened and carried out sweeping reforms of the defense and aviation sectors, including:

- ***Shifting from Administrative to Corporate Mechanisms:*** The outdated management structure was replaced by new corporate arrangements intended to foster market competition. Two new aviation conglomerates, Aviation Industries Corp. of China (AVIC) 1 and AVIC 2, were established and given considerable autonomy along with major industrial enterprises such as Chengdu Aircraft Corp., which is responsible for development of the J-20.
- ***Overhauling the Research and Development (R&D) Base:*** Reforms were launched to break down entrenched compartmentalization by integrating R&D and production activities. Funding for R&D activities was also revamped, with the culling of lower priority and failing projects and more money going into viable, high-priority projects.
- ***Paying Attention to End-User Requirements:*** The aviation industry's blinkered technology-push approach to product development was wrestled open and the PLA, especially the air force, was given the lead role in setting and overseeing equipment research, development, and evaluation.
- ***Changing the Leadership:*** Reform-minded technocrats took charge of the defense and aviation sectors and vigorously implemented far-reaching reforms, including slashing costs and laying off tens of thousands of workers.

The implementation of these and other reforms created the conditions for a remarkable turnaround in the aviation industry's fortunes since the beginning of the twenty-first century:

- ***Financial Performance:*** After more than a decade of losses, the aviation industry became profitable again in 2003 and has posted record earnings and revenue growth annually since then. In 2009, AVIC had profits of US$1.4 billion and revenue of $28 billion, and was also included for the first time on the Fortune 500 list of top global companies.
- ***R&D and Innovation:*** Heavy investment in R&D has led to a strong surge in innova-

tion activities, especially with the establishment of dozens of research laboratories and expansion of aviation universities and institutes. By 2009, AVIC had received more than 5,300 patents, the vast majority of which were obtained in the last few years.

- ***Product Development:*** An extensive range of military aircraft, from fighters to electronic warfare aircraft, has emerged from the Chinese aviation industry over the past 10 years. Chinese air force officials proudly stated that more than 90 percent of the 15 types of military aircraft that took part in the 60th national day anniversary fly-past in October 2009 were indigenously developed products.

While these performance indicators show impressive gains, the aviation industry still suffers from serious structural weaknesses that threaten its long-term ability to narrow the technological gap and catch up with the top tier of global aviation powers. The aero-engine sector, as already pointed out, has struggled mightily to develop and produce state-of-the-art, high-performance power plants.

Another major structural weakness and a legacy of the Maoist past is the widespread duplication and Balkanization of industrial and research facilities. The aviation industry has more than 130 large- and medium-sized factories and research institutes employing 250,000 workers scattered across the country, especially in the deep interior, and often possessing the same manufacturing and research attributes. But intense rivalry, local protectionism, and huge geographical distances mean that there is little cooperation or coordination among these facilities, preventing the ability to reap economies of scale or engage in innovation clustering, and also hampering efforts at consolidation.

The extended cut-off in ties between the Chinese and Western military aircraft industries since the 1989 Tiananmen Square crackdown has also contributed to its technological weakness. But Beijing has fortunately been able to mitigate the severity of these restrictions by forging a close relationship with Russia that has allowed the Chinese aviation industry to gain access to state-of-the-art weapons, and technology and knowledge transfers through off-the-shelf purchases, offsets, and license production arrangements.

THE OVERALL STATE OF THE CHINESE DEFENSE INDUSTRY

The Chinese defense industry is making a concerted effort to build a strong and capable indigenous innovation capacity, but overall progress is at an early stage and focused predominantly on incremental and sustaining types of activities. More advanced forms of innovation, especially disruptive approaches that would lead to important defense technological advances, are likely to be beyond China's reach for the near to medium term, although there may be exceptions in select high-priority areas that enjoy access to ample funding, foreign knowledge and technologies, and leadership support. The J-20 program appears to be accorded this special status.

China has demonstrated that it can engage in radical defense innovation leading to significant technological breakthroughs if the country's security is considered to be in acute danger. This was achieved in the 1960s and 1970s with the development of nuclear weapons and strategic missiles. If China's leaders were to become as seriously alarmed again, this could see another concerted drive to attain breakthroughs in critical defense technological capabilities. This may have occurred in the 1990s with the development of long-range precision ballistic missile capabilities to counter military contingencies involving Taiwan, especially to deny access to waters near China to the U.S. Navy.

China's present approach appears to be the selective targeting of a few critical areas for accelerated development while the rest of the defense economy pursues a more moderate pace of transformation. But as the country grows more prosperous, more technologically capable, and its security interests become more global and complex, this focused strategy is likely to be broadened. The defense electronics, aviation, shipbuilding, and select portions of the space industries are leading the way in the Chinese defense economy's transformation, especially in forging close ties between the civilian and defense economies, access and linkages with global production and innovation networks, the building of innovation capabilities, and ability to adapt to market competition.

To fully understand China's defense innovation potential requires the examination of a broad range of tangible and intangible science, technology, and innovation indicators. This includes not only hard performance measures such as research and development (R&D) budgets, corporate investment, the output of patent, publications, and products, and the size of the science and technology workforce, but also soft process-related factors such as leadership, organizational flexibility, marketing, entrepreneurial skills, risk cultures, and governance factors.

The Chinese defense economy has been investing heavily in the construction of a comprehensive and high-quality innovation apparatus since the late 1990s that is intended to nurture the ability to conduct disruptive technological innovation R&D. This involves the establishment of large numbers of research laboratories, training a large pool of new generations of scientists and engineers, and forging a robust regulatory regime of standards, regulations, and rules designed to impose discipline, oversight, and raise quality control in a previously haphazardly-run system. These structural and process reforms are likely to bear fruit over the next decade and will play an influential role in advancing the defense economy's innovation performance.

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