Preliminary Assessment of China's Next-generation Chengdu and Shenyang Corporation's Stealth-aircraft Prototypes

Background

Videos of two Chinese stealth military aircrafts with tailless advanced designs appeared online in late Dec 2024, sparking global debate about China's growing air force modernisation at rapid pace. Experts have termed their design as highly original, with one aircraft shaped roughly like a diamond, having three air-intakes, and lacking 90-degree angle associated with the stealth design. China's defence ministry and the United States (US) Department of Defence refused to offer any comments. This development is being seen as an attempt by China to dislodge and outpace the US and other European nations from the race to build a sixth-generation fighter program, as the US-envisaged Next Generation Air Dominance (NGAD) and the European Global Combat Air Programme projects are still years away.[1]

Both the aircraft prototypes have been built by China's Chengdu Aircraft Corporation (CAC) and Shenyang Aircraft Corporation (SAC).[2] The larger diamond-shaped prototype's design from CAC indicates speed and stealth capabilities with probable high range and extensive weaponry parameters. But absence of tail for yaw control suggests complicated control surfaces. The other smaller prototype from SAC has a cranked arrow planform design with sharp swept-wing, tricycle landing gears, and two engines.[3]

Defining Sixth-generation Aircraft

Debates are still underway regarding what exactly will be a sixth-generation fighter aircraft. The US remains uncertain about future of their sixth-generation NGAD programme due to high costs. NGAD is expected to have features like the ability to control and operate drone wingmen.[4] As per the Joint Air-Power Competence Centre, a sixth-generation aircraft needs to be capable of detecting hypersonic threats at long range, assess them quickly using Artificial Intelligence (AI) and network support, and engage them with suitable weapons. Further, they should have non-kinetic precision weapons, real-time data exchange capabilities, and a third airstream to provide an extra source of airflow to either improve propulsive efficiency/lower fuel burn or to deliver additional airflow through core for higher thrust and cooling.[5] The CAC's prototype ticks the last parameter with the presence of a third air intake and possible speculations of a ramjet engine propulsion.[6] Sixth-generation fighters

are expected to carry more beyond visual-range weapons and similarly defend itself against such weapons.[7]

Sixth-generation Aircraft Design Challenges

A tailless aircraft requires advanced flight control surfaces and has only been operationalised at the subsonic level, whereas flight performance equivalent to a supersonic fighter jet is far more difficult to achieve with a tailless design.[8] Designing a tailless aircraft can pose challenges in terms of manoeuvrability.[9] Another major challenge in designing a sixth-generation aircraft is implementing and protecting the aircraft's stealth capabilities which depend on its engine technology, exhaust signatures, airframe moulds and designs, radar deceiving technology like broadband and infrared stealth, and exterior paint technology.[10] Further, many conceptual designs never progress to production stage and those that do, undergo significant revisions.[11]

Speculated Design Features of Chengdu Aircraft Corporation and Shenyang Aircraft Corporation's Prototypes

The CAC designed large 'Delta-diamond-winged' prototype appeared to have leading-edge extensions blending seamlessly into nose section, and its dimensions are bigger than J-20. The lack of tails, canards, and strakes could help decrease detection range of multiple radars operating in different bands/quadrants. Tailless design could enhance efficiency and performance during cruise but decrease agility. The control surfaces present below exhausts could be used for semi-thrust vectoring, especially enhanced upward pitch response, but that is not confirmed. The weapons bay looks longer and far deeper than J-20 and could carry multiple long-range standoff weapons. The aircraft has two lower intakes with gapped/splitter design, similar to American F-22, to manage turbulent boundary layer airflow. The upper intake is a bulged fixed-shape Diverterless Supersonic Intake (DSI), similar to American F-35, to provide a regular stream of stable subsonic air. Such three engine intake configurations could lead to unequal total raw thrust output. Three engines provide benefits like electricity generation, cooling, flight control systems, etc. The exhaust design could minimise infrared signature and radar cross-section. This prototype could roughly weigh close to 100,000-115,000 pounds. The canopy design indicates possibility of side-by-side pilot seating arrangement but that's not confirmed yet. It has sideways-looking aerial radar array

apertures, which could expand radar coverage for ground moving target indicator. It features two relatively large electro-optical apertures on either side of nose which could assist in forward-looking infrared search and track abilities, which is not confirmed again.[12] Overall, this type of aircraft appears more suited for performing long-range counter-air, ground, and anti-surface strike, suppression/degradation of enemy air defence roles with objective of expanding tactical airpower far from China's airspace.

On the other hand, SAC-designed prototype appeared to be a heavy-class fighter but smaller than CAC prototype. It has large rhombus-shaped DSI inlets with deep indentation through its ventral centreline starting where inlets converge behind nose, which could possibly separate it from fuselage. There are chances of two separate weapons bays instead of a large continuous one. It has high/mid-set 'Lambda' wing design with speculations of manoeuvring tailplanes. There are at least three major control surfaces per wing. It contains two engines with 2D-jet nozzles which could be utilised for thrust vectoring without tail and signature reduction. This prototype could have a lower gross weight than CAC's model but still in the over 100,000-pound fighter class. This aircraft seems more like a multi-role air dominance fighter aircraft with a substantial combat radius, likely more than J-20, and probably with the ability to super cruise for extended periods with suitable engines but not exactly a super-manoeuvrable aircraft.[13] Its swept wings could be optimised for manoeuvrability at various speed.[14] The smaller design could have advantages in terms of performance, complexity, cost, and could probably fulfil the objective of complementing with CAC's prototype as medium/heavy combat mix.[15]

China's Indigenous Efforts or Design Theft?

China has often faced allegations from the US for stealing their weapon platform design datas and other critical information for its own indigenous military modernisation. The J-20 is said to have similar design as of the American F-22 and the J-35A is believed to be a copy of the American F-35. But in the aftermath of China revealing two new prototypes of sixth-generation aircrafts, expert opinions are also divided. Some experts believe that the newly unveiled prototypes design appears to be highly original.[16] In 2023, Aviation Industry Corporation of China (AVIC) released computer-generated image of conceptual sixth-generation fighter aircraft which appeared to have blended-wing body configuration similar to

the US-based Northrop-Grumman's YF-23 Black Widow Demonstrator fighter, which provides more lift, longer operational ranges, and lesser fuel consumption.[17]

Steve Trimble, a military aviation expert, said that this Chinese prototype design was never seen before. Graham Warwick, another aviation expert, emphasised on the size of the larger prototype to be equivalent to General Dynamics F-111 in terms of wingspan spread and airplanes' length. The upper inlet looks similar to B-2/B-21 bomber. The SAC's design has vectoring nozzles similar to F-22. Tony Osborne, a defence journalist, pointed out that diamond-shaped prototype could be larger than even F-111. He assessed that tandem cockpit having a side-by-side seating arrangement, similar to Su-34 design, could be present in the SAC's prototype.[18]

Estimated Performance Parameters

The CAC's diamond-shaped prototype could have a 55-tonne take-off weight. The delta-wing design could reduce transonic and supersonic drag. Its engines could either be non-afterburning or limited afterburning types used for transonic acceleration. It's three engines could generate a thrust of 22,000 pounds supersonically without using fuel-consuming afterburners at top speeds of Mach 1.8 to Mach 2.[19] A research team from China's AVIC Chengdu Aircraft Design and Research Institute's stealth department maintained that their latest aircraft prototype was using stealth material capable of absorbing high-frequency electromagnetic waves from advanced military radars. This material is said to be thin, lightweight and using low-frequency detection signals to bypass anti-stealth radars.[20]

Its large surface area and angled attack-line triangular wings could help it to gain stability at higher supersonic and hypersonic speeds. Triangular wing gives reduced air resistance to overcome aerodynamic drag which provides better fuel efficiency and higher maximum speed. Triangular wing reduces the likelihood of aircraft stalls at higher angle of attack, which occurs with other wing shapes. Its suitable for aircraft operating at high altitude and high-temperature conditions. Finally, triangular wing is less vulnerable to influence of turbulence in varying weather conditions.[21]

Western and Chinese reactions

The US Air Force (USAF) secretary stated that the newly revealed Chinese aircraft 'Have not had an impact' on their own plans of the next-generation NGAD.[22] Another USAF official acknowledged that China could surpass the US in race to develop world's first sixth-generation fighter jet.[23] As per him, the operationalisation of China's sixth-generation fighters could be as soon as 2030.[24] The USAF Air Combat Command Head is concerned that the American technology and test points supposed to be fielded on NGAD may well be fielded by China instead.[25] USAF officials maintain that they continue to further mature designs and systems' work through technology maturation and risk reduction for NGAD program.[26] Few experts are of the view that the larger CAC prototype could be analogous to FB-22 medium stealth bomber.[27] Leading aviation experts have termed it as a fighter-bomber hybrid or a 'Tactical Bomber'.[28] It is also being thought of being an airborne cruiser with advanced features of sensing, processing, and communications.[29]

A New Zealand-based Chinese analyst believes that the Chengdu prototype could serve as a node in a larger system instead of leading battle from the front and act as a command centre for frontline combat drones, J-20, J-35A, etc. The smaller Shenyang is expected to be suitable for carrier-based operations.[30] Chinese media on the other hand were delighted with the dwindling of stocks of Lockheed Martin, the American fighter jet manufacturer after the videos of Chinese prototypes started circulating.[31] China Academy asserts that the prototypes have already entered mass production and may even be combat-ready. It credits the development of these sixth-generation aircrafts to the hypersonic wind tunnels, which the US lacks at present.[32]

Limitations, Implications, and Conclusion

Japanese experts are of the view that the CAC aircraft's three-engine design appears more to be due to insufficient power rather than advanced design. They also pointed out that blended wing designs don't translate into battlefield effectiveness.[33] The USAF, on the other side, downplays this unveiling as they already boast of flying the NGAD prototype back in 2020.[34] The US experts are also confident that these prototypes are not built for close combat because of lower agility.[35] The implications of this development are both global and regional as it strengthens China's bargaining power in regional and global negotiations.[36] The debut of China's prototypes could likely encourage US to invest further in AI, advanced stealth, and hypersonic weapons and may start a global arms race.[37]

With regards to India, China's next-generation aircraft's potential future deployment along the Line of Actual Control may provide China with enhanced reconnaissance and long strike capabilities, pressuring India as Indian fighters are still limited to 4.5th generation variants.[38] The current limitations of terrain won't be an obstacle for China in future with these next-generation aircrafts.[39] Already ex-Indian Air Force (IAF) Group Captain Ajay Ahlawat has warned that India won't be able to defeat China militarily in the coming next three to four decades.[40] Whether the Chinese sixth-generation prototypes live up to their promise or not is not the primary concern, as the reality is that they can reshape global air-combat dynamics and India can't afford to fall behind.

Endnotesss

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