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Optimizing Obscurity: Advancing Stealth Capabilities and Performance of A BWB Fighter with Symmetric Supercritical Airfoils

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Abstract: The F-22 Raptor is widely recognized as the most dominant aircraft on the battlefield due to its unparalleled stealth characteristics. However, in terms of overall performance, it is not the best. The current article proposes the design of a next-generation blended wing body (BWB) aircraft. A key motivation for using a symmetrical supercritical airfoil is the research gap identified in the literature. This design also incorporates novel approaches such as short take-off and landing capabilities and a dual combustor engine, which are expected to significantly enhance performance characteristics. The double delta wing structure, combined with the BWB design, plays a crucial role in optimizing aerodynamics. Stealth aspects are further improved through the use of advanced coatings and radar cross-section (RCS) reduction techniques. Additionally, the integration of artificial intelligence (AI) brings cutting-edge advancements to aircraft functionalities, while the incorporation of a biometric nosecone ensures that this aircraft represents the next generation in aviation technology.

Table of Contents

1. Introduction

After the world wars, the need for a dominant aircraft emerged. Initially used for early warnings of enemy bombers, radar technology evolved to consider stealth. Aircraft like the F-111, B-1, and Tornado were equipped with radar systems for low-altitude flying. However, using radar at low altitudes in combat was risky, as its effectiveness was diminished by ground reflections. Researchers proposed optimizing radar cross-sections and using radar-absorbent materials. Yet, the radar detection range was limited by the fourth root of the radar cross-section, and absorbent materials increased drag and weight. The DARPA organization awarded the stealth fighter contract, and through the persistent efforts of leading organizations like Lockheed Martin, stealth technology emerged. Besides the US, various other countries developed different stealth aircraft. The Rafale fighters recently acquired by India from France are also stealth fighters, though not on par with US fighters.

1.1. The Specialities of F22

The most important feature of the F-22 was its design and shape. All the hard edges, including nozzle inlets and the engine, were aligned parallel at a constant backsweep angle. This alignment directs incoming radar waves away from the aircraft, creating a narrow, low-observable spike. The F-22 has a continuous body with varying cross-sectional radii. The aircraft also features saw-toothed breaks in the skin, including around the landing gears, which can compromise the stealthy nature of the aircraft. To reduce radar wave reflection, radar-absorbing material was used, converting incoming radio waves into thermal and magnetic energy. These materials were applied specifically to cover the breaks. The cockpit and cabin also needed to be invisible to

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radar. Unlike the F-117, the F-22's cockpit was designed with a 360-degree view for the pilot, and the canopy was coated with radar-reflective materials [1].

1.2. Basic Idea of a BWB

The F-117 aircraft was a highly swept and blended wing body (BWB) aircraft. It featured elevons as control surfaces, along with fly-by-wire technology integrated into the aircraft. The body of the aircraft was constructed with flattened panels and very small radii for both the leading and trailing edges of the wing. The concept of a blended wing body aircraft was initially introduced by NASA in 1988. Their research indicated that this type of aircraft consumed less fuel and exhibited increased efficiency. This design integrates the fuselage and wing into an airfoil-shaped body, with the fuselage contributing to lift generation. Additionally, the interference drag typically present in conventional configurations due to the fuselage and wing is minimized. The overall reduction in wetted area also results in decreased friction drag. To enhance stability, it is recommended that engines be positioned at the rear rather than on the tail. Furthermore, the fuselage can be utilized as an inlet duct for air [2].

1.3. Concept of Symmetrical Supercritical Airfoil

The airfoil is the heart of an aircraft, and the characteristics of an aircraft are largely defined by the selection of its airfoil. This paper proposes the concept of a symmetrical supercritical airfoil. Cambered supercritical airfoils cause an increase in the drag divergence Mach number. When airflow passes over an airfoil, the boundary layer can separate due to the formation of shocks. However, if the airfoil shape is symmetrical, the intensity of these shocks decreases, reducing separation. This can be achieved by increasing the radius of the leading edge and decreasing it for the trailing edge. A larger radius of the leading edge tends to produce a larger normal force. The further curvature of the airfoil should be designed in such a way that the expansion wave produced reflects from the sonic boom, decreasing the velocity of the flow. The portion near the trailing edge of the airfoil should be shaped to prevent an increase in the intensity of the shock. These principles were examined in experiments conducted in the Langley 8-foot transonic pressure tunnel. The selection of an airfoil is based on the type of aircraft being manufactured. If the goal is to build an aircraft with a focus on stealth, even if it compromises performance, the above supercritical airfoil would not be used. Instead, reverse airfoils, which provide a minimum cross-sectional area, are employed in the construction of stealth aircraft [3].

2. Literature Review

2.1. BWB Consideration

Vivek Kumar Shrivastav et al. [4] conducted a study on the aerodynamics of aircraft components. The primary contributor to lift in an aircraft is the wing, while the fuselage plays a minor role in lift generation, primarily contributing to skin friction drag similar to the wing. Additionally, the empennage section is crucial for providing stability to the aircraft, although its contribution to lift is minimal. Consequently, the significance of flying wing aircraft has been amplified. Flying wing aircraft are proficient in accommodating fuel, payload, engines, and other components, leading to an increase in inertia. This increased inertia results in shear loads that counteract the bending loads exerted by the weight of these components, thereby aiding in lift generation. The groundbreaking work of J.K. Northrop during World War II led to the development of the XB-35 bomber, which was later transformed into the jet-engine aircraft known as the YB-49. Despite the enhanced aerodynamic efficiency of this configuration, it failed to reduce fuel consumption and improve overall efficiency.

A novel concept of a blended wing body (BWB) was introduced by NASA Langley Research Center, in conjunction with the design of Very Large Aircraft (VLA). A second-generation BWB was subsequently designed, featuring a wing area of 727 m^2 and a wingspan of 85 m. Designers anticipate a 30% to 40% improvement in fuel efficiency with the utilization of next-generation aircraft incorporating open rotor motors or high bypass ratio turbofan engines. This innovative approach holds promise for a Green Revolution, offering environmentally friendly configurations to the aviation industry.

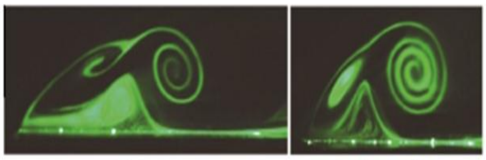
P. Panagiotou et al. [5] conducted a study on the various layout configurations of a blended wing aircraft. The layout includes a reflexed airfoil with a curved camber towards the trailing edge. As airflow passes over this airfoil, the velocity decreases on the upper surface compared to the lower surface, altering the subsequent pressure distribution and lift, resulting in the creation of a positive pitching moment coefficient from a negative lift coefficient. This characteristic explains why reflex airfoils naturally have a positive pitching moment coefficient.

Three different configurations were analyzed to identify the optimal design. The initial setup featured a V-shaped tail, which proved effective for pitch and yaw control. However, this design increased the wetted surface area and reduced the aircraft's efficiency. The second configuration incorporated a canard for longitudinal control, with rudders positioned near the winglets and elevators mounted on the fuselage. Despite this, the higher number of control surfaces expanded the wetted area, and the central body failed to enhance aerodynamic efficiency due to the wake generated by the canard. The third design integrated distinctive elements like winglets for pitch and yaw control and elevators for pitch and roll control. No control surfaces were attached to the central body in this layout, allowing more space for internal components. The increased distance of the control surfaces from the central body extended the lever arm and decreased the area of the control surfaces, consequently reducing the wetted area.

2.2. Aerodynamics of Double Delta Wing

Mojtaba Dehghan Manshadi et al. [6] conducted a study on the aerodynamic characteristics of the flow around a double delta wing of an F-16 fighter aircraft. The presence of sharp leading edges on the wing results in premature flow separation, leading to the formation of a primary vortex due to the slender geometry of the wing. The spanwise flow induced by this primary vortex creates suction pressure, causing the boundary layer to separate due to adverse pressure gradients, which consequently generates a secondary vortex. The trajectory of the primary vortex remains unaffected by changes in the angle of attack. Conversely, in a non-slender body, the primary vortex forms above the area shared by the fuselage and the wing. The secondary vortex emerges in the separated flow with a similar rotational direction but reduced intensity. The wing design, resembling that of the Northrop Grumman X-47 aircraft, was examined. Experimental investigations were carried out in a low-speed wind tunnel to analyze the flow characteristics during takeoff and landing operations. The experimental setup aimed to compare the computational results for wings with sharp and rounded leading edges. The findings revealed that the primary vortex was mainly situated near the wing's centerline, while a secondary vortex of lesser intensity formed farther away. The size and intensity of the vortices were affected by the angle of attack for delta wings. The correlation between the pressure coefficient and angle of attack showed an increase in the intensity of the primary pressure zones with higher angles of attack, along with a decrease in the size of low-pressure areas. These observations demonstrated the expansion of the vortex based on aerodynamic conditions.

The distribution of the pressure coefficient above the wing surface in the spanwise direction was examined. Due to the stochastic characteristics of the vortex core, it deviates erratically from its mean position, resulting in an increase in the fluctuating kinetic energy of the vortex core. These vortex cores were found to be unaffected by the Reynolds number of the flow and the geometrical features encountered in their trajectories. The specific positioning of the vortex cores is dictated by the root mean square velocity. As the vortices travel a certain distance at a designated angle of attack, they disintegrate over the wing section. An increase in the angle of attack causes the disintegration point to shift towards the wing's tip. Complete separation of the flow is observed at the wing's tip, accompanied by a significant expansion in the vortex's diameter, leading to a rapid decline in the aircraft's lift generation. Furthermore, this phenomenon impacts the aircraft's maneuvering capabilities.The chordwise dimensions reveal that the outer wing is smaller in magnitude compared to the inner wing. The peak value of the lift coefficient is observed in close proximity to the wing's root. Observations indicate that the wake structure begins to form at an angle of attack of 10 degrees and separates towards the wing's trailing edge. Turbulent characteristics of the flow are discerned at the quarter-chord section near the wing's trailing edge at the same angle of attack.



(a) $\alpha=12°$ (b) $\alpha=18°$

Figure-1 Formation of the dual vortex structure above a 60 degrees delta wing [6]

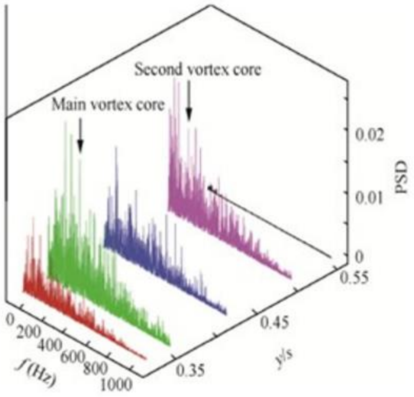


Figure 2: Pressure distribution above the wing [6]

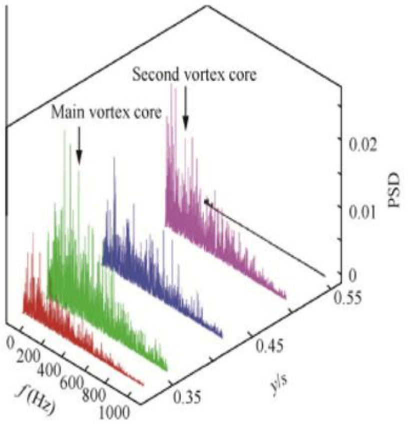


Figure 3: Spectra of velocity fluctuations [6]

2.3. Twisting Effects on a Wing

The concept of the SMA (Shape Memory Alloy) wing was introduced by Ruhollah Karimi Kelayeh et al. [7]. They investigated the effects of changing twist angles on aircraft performance. The absence of a tail results in an increase in the sweep angle. Moreover, this increase in the aft sweep angle contributes to an improvement in the longitudinal stability of the lambda wing. However, the main issue with this configuration is the poor performance of the wingtips at significantly high angles of attack due to flow separation effects. This issue is addressed through the implementation of washout, which decreases the angle of attack at the outer part of the wing. Additionally, washout reduces the induced drag of the aircraft, leading to lower fuel consumption. Nevertheless, experimental analysis indicates that the results of washout and washin were unfavorable.

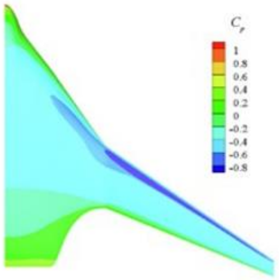
This circumstance prompted the adoption of intelligent geometry morphing to alter the wing and body shapes in accordance with the mission profile of the aircraft, thereby enhancing its aerodynamic efficiency. A smart wing capable of morphing was subjected to aerodynamic testing following three distinct instances of geometrical twist modifications. The findings revealed that an increase in twist angle led to an increase in the lift coefficient and a decrease in the drag coefficient, consequently elevating the aerodynamic efficiency of the aircraft. The increase in twist angle also bolstered the longitudinal stability of the aircraft while mitigating the effects of shear stress.

2.4. Structural Analysis of a Fighter Aircraft

Usmah Tariq et al. [8] conducted a comprehensive study on the structural analysis of a fighter aircraft. The wings of the aircraft receive the majority of their support from spars that are strategically positioned in the spanwise direction. These spars play a crucial role in withstanding the twisting and bending moments resulting from the loads acting on the wing. It is imperative for the spars to be constructed from robust materials to effectively withstand external forces. Additionally, ribs are responsible for bearing the total load of the wing and are typically positioned in the chordwise direction. Fighter aircraft are typically equipped with three different types of spars to enhance their structural integrity. The team utilized the Von-Mises theory to calculate the yield stress, taking into account the energy per unit volume. The simulations were carried out using titanium and aluminum alloys.

Wensheng Zhu et al. [9] employed a modified and suitable technique for predicting the structural mass of BWB (Blended Wing Body) aircraft in their study. The utilization of non-ideal components serves the dual purpose of enhancing safety and accounting for potential failures in ideal components. These non-ideal components encompass high lift devices and flight control elements. The linkage between the inner wing and the fuselage is established through spars, ribs, and skin panels. Evaluation of the fuselage structural masses for each component was conducted using specific empirical formulas. The determination of the wing box mass involved the consideration of both ideal and non-ideal components. Secondary structures such as high lift devices and flaps were assigned masses based on empirical formulas.

The findings revealed that the structural mass of the fuselage exceeded that of the wing by one and a half times. Notably, the nose and tail sections of the fuselage accounted for less than 10 percent of the total structural mass. The structural mass of secondary wing components amounted to a quarter of the fuselage structural mass. The authors inferred that the fuselage frames must possess adequate strength to withstand bending moments induced by various loads. Additionally, components such as engines and landing gear contributed to the overall mass of the fuselage. An optimization process was implemented to determine the minimum mass for each structural component, spanning four iterations. The thickness of the skin and the areas of the stringers showed an incremental trend until reaching a peak value at the common section of the inner and outer wing. Subsequently, these values decreased from the beginning to the end of the outer wing. Notably, the upper surface skin exhibited greater thickness compared to the lower surface skin, leading to compressive forces on the upper surface due to bending stresses.



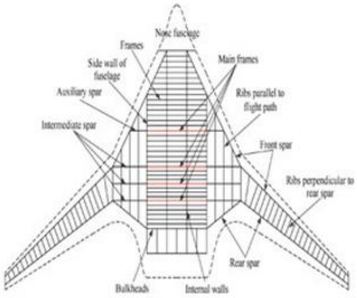
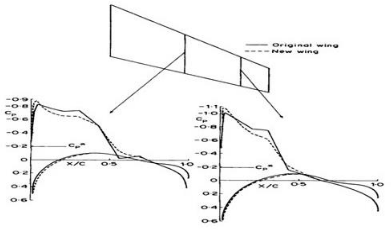


Figure-4 (left) Surface pressure coefficient distribution at cruise condition. Figure-5 (right) Structural Layout of a baseline BWB Aircraft [9]

3. Study of Supercritical Airfoils

Richard T. Whitcomb **[10]** conducted an analysis of NASA's supercritical airfoils, highlighting their unique characteristics, such as reduced curvature in the mid-chord region and increased camber at the trailing edge. Early research on NACA 4-digit airfoils suggested their suitability for propeller blades in high-speed applications, but subsequent studies on NACA 6-digit airfoils demonstrated superior performance. Both supercritical and subcritical airfoils showed lift coefficients exceeding specified values, underscoring the importance of upper and lower boundary layer thickness in their design. These findings emphasized the enhancements in aircraft speed and maneuverability due to these advanced airfoils, leading to a significant reduction in fuel consumption. While prioritizing 3D wing geometry and sizing over airfoil selection is common in combat aircraft construction, the author argues that airfoil selection could be a pivotal factor. Although supercritical airfoils offer improved aerodynamic efficiency, they also introduce undesired wave drag. The implementation of symmetric modified camber in supercritical airfoils is advantageous for supersonic speeds, complemented by the use of leading and trailing edge flaps.

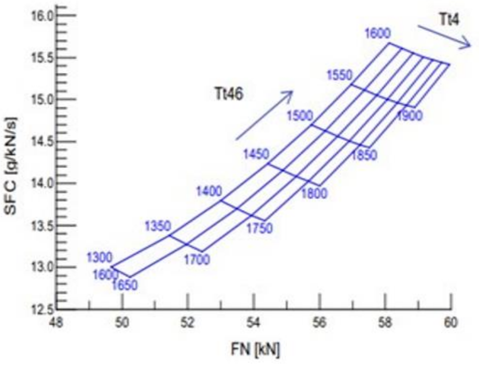
M. Nandanan et al. **[11]** conducted a study focused on optimizing supercritical airfoils to reduce wave drag. Their approach involved using a fictitious gas to modify the upper surface of the selected airfoil, aiming to achieve shock-free flow. Adjustments were then made to the lower section of the airfoil to ensure symmetry. The process involved converting a finite 3D wing into 2D geometry, followed by reverting the airfoil to a symmetrical configuration and aligning it back to the streamline section, considering the wing's sweep angle. The outcomes indicated that the revised airfoils exhibited shock-free characteristics on the upper surface. Notably, the pressure distribution for the modified airfoil remained consistent with that of the original airfoil, with a significantly reduced shock strength. Moreover, the lift coefficients for both the wing and airfoil were equivalent to those of the initially selected airfoil, leading to a reduction in drag for the modified airfoil. Furthermore, the modified airfoil demonstrated improved performance even under off-design conditions, and the introduction of twisting effects did not impact the results of the modified airfoil. **Figure-5 (towards right) shows the comparison of surface pressure distribution of conventional wing and new wing [11]**



3.1. Novel Propulsion System

Arvind Gangoli Rao et al. [12] proposed the concept of a hybrid engine. The intention behind this sustainable method was to reduce the reliance on carbon-based fuels. It stores a small amount of energy as cryogenic propellant in the large fuselage section, while the remaining energy is derived from biofuel. As a result, it is a multifuel propulsion system that combines LH_2 (cryogenic fuel) and LNG (biofuel). The engine utilized in this propulsion system features unique characteristics, such as the ability to utilize two fuels and a reduction in the emission of polluting exhaust gases. The boundary layer injection technique is employed to enhance propulsive efficiency, and the engine is mounted on the surface to reduce the nacelles' related area.

In the two combustion chambers, the first one contains LH_2, while the second one holds the biofuel. All the heat is added to the first chamber by increasing the temperature of the operating cycle. The combustion of hydrogen reduces NO_2 emissions by increasing the amount of water vapor compared to oxygen for flameless combustion of biofuel. The temperature rise in the bleed air caused by the increased pressure ratio is reduced by the cryogenic fuels, which act as a type of heat sink. A counterclockwise rotating fan was used to address the flow instability caused by boundary layer ingestion. Additionally, the engine diameter was reduced, and it was mounted inside the nacelle to decrease the nacelle wetted area. Variation of specific fuel consumption and thrust with the IBT inlet temperature and combustion chamber outlet temperature The fuel consumption formula for a blend of two fuels was modified by multiplying the mass rate of the cryogenic fuel by the ratio of its lower heating value to that of kerosene. The Gas Turbine Simulation Program utilized an interstage turbine burner with two Interstage Burner Turbines. As the temperature prior to the interstage burner rose, the specific fuel consumption (SFC) decreased, leading to an increase in specific thrust. Conversely, with an increase in temperature after the combustion chamber, both the SFC and specific thrust increased.



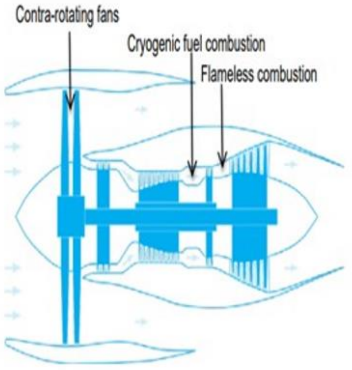


Figure-6 Variation of specific fuel consumption (left); Figure-7 Schematic of a hybrid engine along with thrust concept (right) [12]

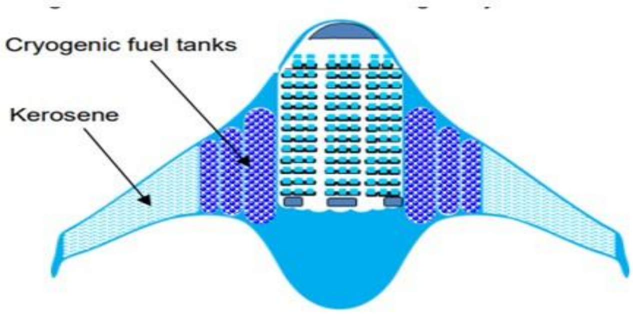


Figure-8 A multi-fuel blended wing body aircraft [12]

The study also included a graph depicting the relationship between specific fuel consumption and fuel bypass ratio at various bypass ratios. The curve was identical to that of traditional turbofan engines, demonstrating that as the bypass ratio increased, the specific fuel consumption decreased. The results revealed that the optimized fuel bypass ratio for a fixed bypass ratio was higher for a hybrid engine.

3.2. Mounting of the Nacelle

Liu Yang [13] investigated the effects of nacelle positioning on flow separation in blended wing body (BWB) aircraft. The study explored both vertical and horizontal mounting distances relative to the longitudinal axis. Typically, BWB designs place the engine at the rear, which can lead to flow separation and surge effects. Simulations using Ansys CFX revealed that increasing the nacelle height reduces the area of flow separation. At a height of 1000 meters, flow separation is completely eliminated. Rear-mounted engines can optimize flow near the symmetry plane, though separation regions may reappear, ultimately improving the flow field quality for the BWB.

3.3. Short Liftoff Performance

Liu Yang et al. [14] explored methods for reducing lift-off and landing distances, which also enhance thrust vector control. The approach involves vertical landing and rolling, necessitating modifications to the propulsion system, such as the use of a lift fan and three ducted nozzles. The fan and nozzle rotation are adjusted based on the mission profile. During lift-off, nozzle rotation generates partial lift, while the fan improves forward acceleration by reducing wheel force and friction. The fan deflection angle remains constant during takeoff, with the shortest lift-off distance achieved when the lift fan is half its original size.

For landing, the aircraft's landing path was optimized to find an appropriate touchdown point. The gliding angle determined the required airspeed, and velocity stability was analyzed through the differentiation of the thrust vector with respect to dynamic pressure. This analysis established safe landing zones across various pitch angles. The results demonstrated improved landing performance with minimal altitude deviations and accurate speed notations, allowing for a smooth cruise mission. Pitch angle values showed minimal variation, and the rolling angle remained consistent.

4. Stealth Considerations

4.1. Historical Aspects

The F-117 aircraft utilized flat panels to minimize radar reflection, and ferrite polymer coatings were applied to the aluminum skin to further reduce reflectivity. Despite infrared sensors' effectiveness, detecting the aircraft in foggy or cloudy conditions was challenging. In 1978, the US Air Force awarded the stealth fighter contract to Lockheed Martin and Northrop. Northrop introduced innovations such as 3D curvature with varying radii and S-ducts. The B-2 Bomber, constructed with carbon-fiber and designed with a leading-edge shape to absorb radar signals, eventually replaced the F-117. The B-2's frontal radar cross-section was 100 times smaller than that of the B-1.

4.2. Introduction to Stealth Technology

Bipin Kumar Jha et al. [15] provided an overview of stealth technology, which became available after World War II. Early radar technology was used by the Germans, and Northrop's YB-49, a flying wing aircraft, demonstrated reduced radar detectability. The US, interested in producing less detectable spy planes, collaborated with Lockheed and California's top designers to develop a new U-2 design. Stealth technology aims to partially render aircraft invisible to radar, similar to how soldiers use natural cover to avoid detection. Radar systems use radio waves to detect aircraft, with waves bouncing off surfaces and returning to the radar. By measuring the return time and speed of sound, the aircraft's position is determined. Enhancing stealth involves using absorbent materials and optimizing aircraft shape.

4.3 Study of the Shape of Stealth Aircraft

D. Howe's study [16] examined the fundamental principles of stealth technology in fighter aircraft. Aircraft emit various signals during flight, including visible, infrared, and audio signals. Audio signals diminish with distance, but propeller aircraft can generate audible warnings due to their shorter wavelengths. Key noise sources include the engine, compressor assemblies, combustion-turbine assemblies, exhaust systems, and the airframe, with local flow interactions producing more noise than boundary layer noise. To mitigate audible noise, sound absorbers and increased bypass ratios can be utilized, while converting inlet guide vanes into curved ducts can reduce front-end noise. Additionally, fighter aircraft emit thermal signals in the infrared range, which can be used for tracking and identification. The wavelength and radiation energy of these signals depend on temperature and emissivity, which must be managed effectively for enhanced stealth.

4.4 Basic Stealth Technology

D. Howe's study [17] further explored the fundamentals of stealth technology in fighter aircraft. Key signals emitted during flight include visible, infrared, and audio signals. Audio signals decrease with distance, but propeller aircraft can generate detectable noise. Major noise sources are the engine, compressor assemblies, combustion-turbine assemblies, exhaust systems, and the airframe, with local flow interactions being significant contributors. To reduce noise, sound absorbers and increased bypass ratios are used, and curved ducts can mitigate front-end noise. Thermal signals in the infrared range are significant for tracking and identification, with emissivity and temperature affecting the wavelength and radiation energy. Effective management of these signals is crucial for optimal stealth performance.

5. Sixth or Next Generation Concept

Funk et al. [18] proposed a versatile military aircraft concept to enhance the US military fleet, complementing existing advanced fighter jets like the F-22 and F-35. The objectives included increasing loiter time and survivability in combat. The concept included various configurations such as LO (low observable) and STOL (short takeoff and landing) capabilities, compact LOL (long-range, low-observable) aircraft for bomber and attack missions, and larger platforms for cargo and tankers. Modifications included using medium bypass ratio engines for gunships and bombers and high bypass ratio engines for cargo and tankers. Aircraft were categorized by size, with large aircraft for cargo and tankers and small VTOL (vertical takeoff and landing) aircraft for gunships and bombers, providing tailored solutions for diverse missions.

Raghu Chaitanya Munjulury et al. [19] proposed a future combat aircraft design featuring stealth with supercruise capability. The design emphasized enhanced maneuverability through thrust vectoring and the integration of advanced sensors for autonomous operation. Inspired by the McDonnell Douglas X-36, the design used an S-shaped duct around the F-110-132 engine and employed thrust vectoring with one engine for a lighter, pilotless aircraft. Advanced sensors and autonomous systems were highlighted as crucial for future operations, enabling aircraft to act as command hubs for unmanned aerial vehicles.

Jieliang Zhao et al. [20] designed a bionic nose cone inspired by honeybee biology. By studying honeybee abdomens, which can bend up to 20% longer in a vertical plane, they developed a nose cone with ring-shaped cells that adjust shape according to mission requirements. This biomimetic design enhances the adaptability and functionality of the nose cone for various applications.

Purabi Sharma et al. [21] presented AI techniques for electronic warfare in fighter aircraft. Modern electronic warfare tools control radio frequencies to disrupt and safeguard against enemy electromagnetic fields. AI techniques, including artificial neural networks, are employed to analyze and classify signals. These advancements are crucial for electronic warfare, both on and off the battlefield, playing a key role in fighter aircraft operations.

6. Conclusion

There have been numerous papers discussing commercial and transport airplanes that utilize blended wing body (BWB) designs; however, I have found no accessible research on BWB stealth fighters. While such research may exist, it has not been made publicly available, likely due to confidentiality concerns. This gap in the literature underscores the need to incorporate this concept into the proposal. The most significant research gap indicates a lack of focus on both stealth features and performance. Most studies have concentrated on enhancing aerodynamic aspects. I hope this proposal will address these issues to some extent. The proposed next-generation stealth fighter aircraft aims to surpass the F-22 by incorporating advanced technologies. The symmetrical supercritical airfoil has been revisited due to research gaps, and the Blended Wing Body (BWB) design reduces planform area and skin-friction drag. The innovative engine design supports green aviation by minimizing carbon emissions. Enhanced takeoff and landing distances improve the thrust-to-weight and lift-to-drag ratios. Stealth technologies discussed include advanced coating techniques and optimized aircraft shapes, addressing performance and stealth trade-offs. The proposed biometric nosecones offer adaptability for various mission profiles, and the integration of AI promises increased autonomy for future aircraft. Inspired by programs like India's AMCA, developing countries are encouraged to invest in next-generation stealth technology to drive innovation and self-sufficiency.

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8. Conflict of Interest

The author declares no competing conflict of interest.

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11. Author Biography

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