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Stealth Aircraft Technology

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Abstract:
Stealth Aircraft use Stealth Technology so as to avoid detection by using combination of features so that Aircraft can interfere with RADAR and also reduce the visibility in radio frequency (RF) spectrum, audio and infrared visual. During the last decades, stealth technology has proven to be one of the most effective approaches as far as the endeavour to hide from radar systems is concerned. Stealth means to avoid the detection or try to hide, For airplanes, hiding from radar meant stealth. The concept used in the stealth technology is not so difficult. It uses the principle to absorb and reflect the radar waves. Aircraft deflects the radar waves in various directions and minimizes the radar waves which return backs to radar. Another phenomenon which allows the aircraft to absorb the incoming radar waves totally and to divert the imbibed electromagnetic energy in different direction. The design and material used to build aircraft decide the level of stealth achieve by aircraft. The idea for the radar antenna to discharge radio energy, which is then send back by any object it happens to detect. The time taken for the reflection to come is measure by the radar antenna and it can tell how distant a object is

I. INTRODUCTION

2.1] WHAT IS MEAN BY STEALTH?

In simple words, stealth technology enables an aircraft to be partly invisible to Radar or any other possible way of spotting the Aircraft this does not mean that aircraft is fully invisible. Stealth only reduces the detection range of an aircraft. We can compare stealth technology with tactics used by soldiers in jungle warfare in which soldiers hides themselves by covering their bodies with leaves or branches to make it harder to see. You can only see the soldiers when they come near you. It gives aircraft safe striking distance but there is always some chances to detect by radar.

2.2]STEALTH HISTORY:

In the late 1930's and 1940's for detecting aircraft radar technology was commonly used. During Second World War stealth technology was developed. Germans are the only who worked on the project they were responding to the success the Allies were having with the early radar sets. Not only was their radar efficient to spot incoming enemy bombers, but it also plays important role in the battle for the Atlantic. The German discover a radar absorbing paint (RAM) but this ferrite-based paint was very heavy for aircraft, so it could be applied on submarines. After the war, Northrop Aircraft of United States developed an bomber called the YB-49 Flying Wing. It was simply a large flying wing with no body or tail. During one of the test flight over pacific when aircraft returning back to home it was observed that radar screens was not able to detect the presence of aircraft until it come close ande suddenly it appeared almost overhead of radar crew. When the bomber crashed in the Mojave Desert in 1948 Interest in the project quickly reduced. During the flight, the plane was unstable and this listed as cause of the crash. With the "cold war" and the Soviet Union well under way in the early 1950s, it became necessary that the U.S. should learn about military developments. Old bombers were converted to spy planes, but they were not so effective. To reduce this intelligence gap, a new plane was developed. Basic idea was to create a plane that could roam securely at very high altitudes, compared to any existing fighter. The design base on basic specification of "to reduce the detect ability by enemy radar." The working was started at Lockheed in California. Team consists of highly qualified and highly motivated engineers and pilot. The aircraft they developed by them became known as the U-2, and it was highly successful.

2.3] WHY STEALTH REQUIRED:

Due to the pronounced improvement of the detection techniques rapid development of stealth technology occurred like radar's as they were the most frequently used detections methods in the 1930's & 40's. There are some tactics that nourishes the development of the Stealth technology such as use of Radar Aided-Anti aircraft systems and the use of Sonar's for detecting the presence of Submarines by the Ships etc. As Stealth technologies touching new heights in development in the other side AntiStealth technologies are also in boost to reduce the capabilities of the Stealth technologies. Thus it determines the need of

II.STEALTH TECHNOLOGY.

4) ANATOMY OF RADAR

RADAR i.e. Radio Detection And Ranging, thus as it is abbreviated so uses radio waves for detection of the target. Radar is normally invisible but it is always in use all around us. To track planes on the ground air traffic control uses radar, and also to guide planes in for safe landings. Radar is also used by police to detect the speed of moving cars. To map the Earth and other planets, to track satellites and space debris and to help with things like docking and manoeuvre NASA uses radar.

4.1.2] DOPPLER SHIFT:

This is the second principle of the radar. This effect is more commonly used for sound. The sound that you hear as a vehicle is moving towards you is at a higher pitch or a higher frequency than the sound you hear when the vehicle is moving away from you. Same property can be used by radar to determine the speed of the object. The frequency of the reflected wave can be the same, greater or lower than the transmitted radio wave if the reflected wave frequency is

higher so this means that the target is moving towards the transmitter and if lower then moving away from the transmitter and if constant then the target become steady like a helicopter hovering at a point. This can be used to predict the speeds of the target too. Doppler shift occurs when sound is generated by, or reflected off of, a moving object. Consider the car was moving toward you as similar the speed of sound i.e. 700 mph, so the car is blowing its horn. Horn created the sound waves which cannot go faster than the speed of sound, so both the car and the horn are coming at you at 700 mph, so all of the sound coming from the car get "stacks up." And you hear nothing, but you can see the car approaching towards you. At exactly the same moment the car arrives, so does all of its sound and it is LOUD! That is a sonic boom.

4.2]Radar Cross Section (RCS):

Radar cross section is the measure of a how much Radar signals reflected by target with respective the direction of radar receiver, i.e. it is the ratio of backscatter power per steradian (unit solid angle) in the same direction of the radar (from the target) to the power density intercepted by the target. The RCS of a target can be viewed as comparison of the strength of the reflected signal from a perfectly smooth sphere of cross sectional area of 1m to the reflected signal from a target. But in actual case, not all of the radiated energy falls on the target so target's RCS (ó) is most easily visualized as the product of three factors:

σ = **Projected cross section * Reflectivity * Directivity.**

Reflectivity: It is the ratio of percent of intercepted power reradiated (scattered) by the target. Directivity: It is the ratio of the power scattered back in the radar's direction to the power that would have been backscattered had the scattering been uniform in all directions (i.e. isotropic ally).

For a sphere, the RCS, ó = ðr^2 , r is the radius of the sphere.

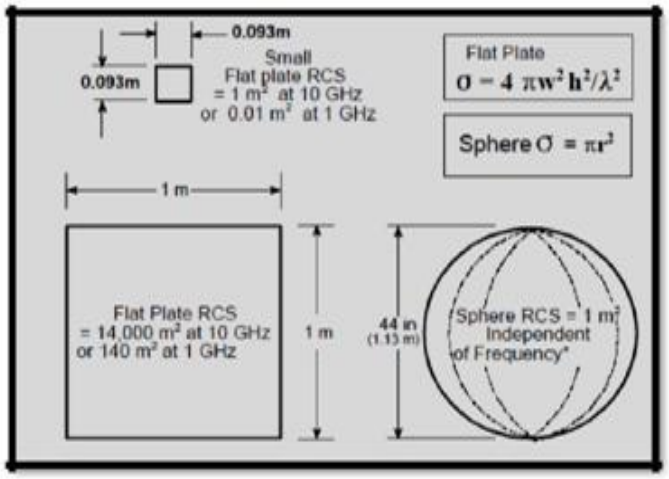


Figure.4.3 RCS vs. Physical geometry

As shown in fig. the RCS of a sphere is independent of frequency if operating at sufficiently high frequencies where ë<<Range, and ë<< radius (r).

The importance of radar cross section can best be understood by looking at an equation relating the RCS of the target to the energy received by the radar.

S≅ [Pavg*G* ó*Ae*tot] / [(4ð)^2*R^4]

Where, S = Signals energy received by the radar

Pavg = average power transmitted by the radar

G = gain of the radar antenna

σ = radar cross section of the target

Ae = effective area of the radar antenna

tot = time the radar antenna is pointed at the target (time on target

R = range to the target

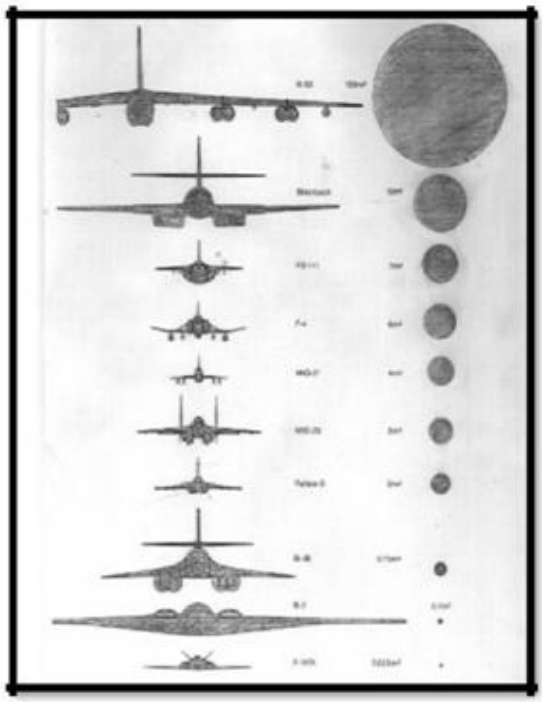
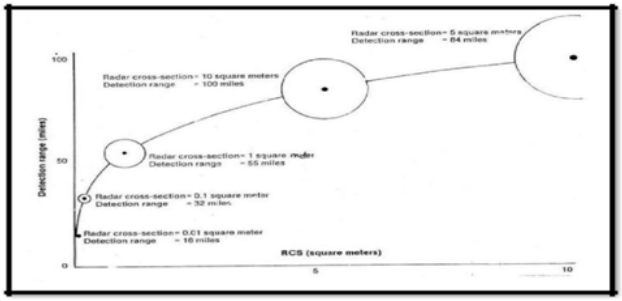


Figure.4.5 Physical size of aircraft compared to it'sRCS

4.2.1) DETECTION RANGE:



Figur.4.6 Detection range

Fig.4.6 shows an aircraft having largest RCS get detected over the range of 100 miles. As soon as the RCS goes on decreasing the range for detection of aircraft goes on decreasing too. In case of stealth aircraft we are going for the minimum RSC. As told earlier stealth aircraft are partially invisible on radar, means they are get detected on radar but due to their small RCS their signals on the radar are not recognized as an aircraft. Whenever they get traced on radar they have already reached the deep enemy territory for accomplishment of the mission. Ultimately the point is that, the element of surprise is maintained. In this way this diagram accentuates on the significance of the RCS in terms of the detection range of an aircraft.

4.2.2] METHODS TO REDUCE RSC:

4.2.2.1] SHAPING:

Geometry is one of the important factor affecting the RCS or the shape of the target, not its size. In order to reduce the RCS, the surfaces and edges should be orientated in such way so as to reflect the radar energy away from an expected radar antenna and not back to it.

4.2.2.2] USE OF RADAR ABSORBENT MATERAIL (RAM):

The special shaping is the most important method and it is responsible for the main part of RCS reduction. The second technique is the use of special Radar Absorbent Materials (RAM) which absorb (part of) the received radar energy and convert it to heat, reducing in this way the reflected energy.

RAM neither absorb all received radar energy, nor are efficient at all frequency bands. It is considered as a supplementary approach, helping in reducing RCS when shaping techniques cannot be applied, e.g., in leading edges or engine intakes.

5] ELEMENTS OF STEALTH AIRCRAFT DESIGN

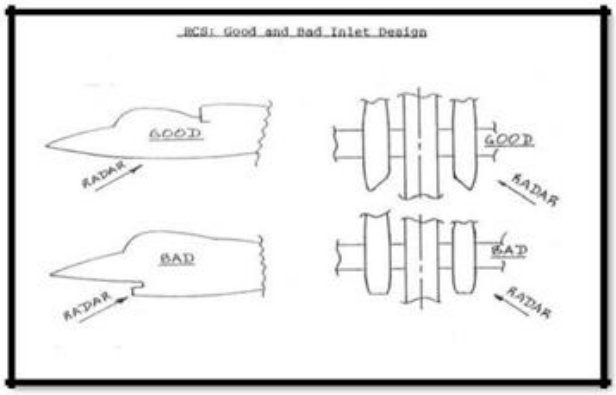


Figure.5.1 Inlet design

As shown in the fig.5.1 the inlet design should be fitted in aircraft body such that it should not bulge outward forming a protrusion. Such protrusion provides more surface area for radar signals for the reflection. The bad design of inlet in the fig. is of F-16 aircraft which is the conventional one,

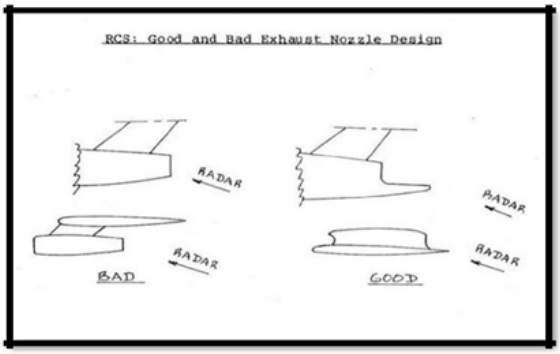


Figure. 5.2 Nozz

Fig. 5.2 shows the design of exhaust nozzle of aircraft. As shown in fig. a good stealth aircraft should have its exhaust nozzle situated very close to its body so that it should not make any protrusion in outward direction. In fig. a bad exhaust nozzle is shown, it is the design of Il-76 military transport and cargo aircraft which is not stealth in nature explicitly. Therefore a stealth aircraft should have its exhaust nozzle closed to the body of aircraft.

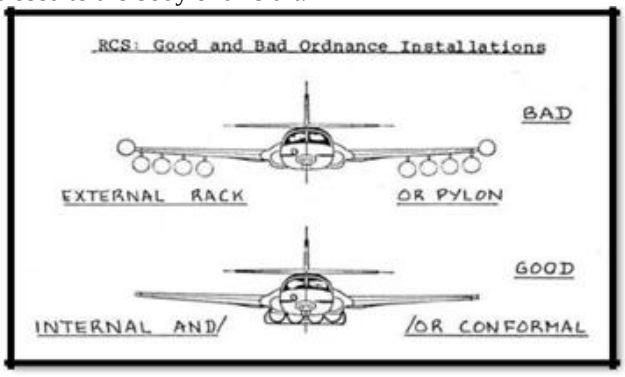


Figure.5.4 Ordinance installation design

Fig. 5.4 shows the ordinance installation design of stealth aircraft. In case conventional aircraft whatever the armament is to be fitted on aircraft body, is fitted to its wing. But in this case, the bombs, missiles and whichever armament fitted to the wings of aircraft becomes a protruding part of the aircraft causing detection on the installations of B2 bomber of USAF

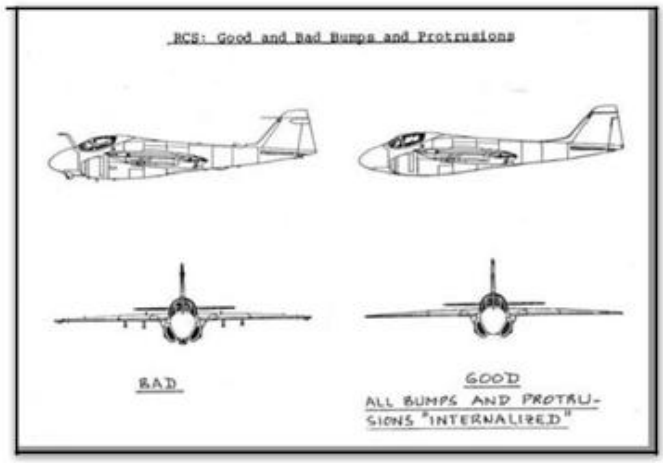


Figure.5.5 Overall design

6).INDIA'S INITIATIVE IN STEALTH AIRCRAFT TECHNOLOGY & PROS AND CONS OF STEALTH TECHNOLGY

6.1) DRDO AURA:

Defence Research and Development Organisation developed **AURA** i.e. (Autonomous Unmanned Research Vehicle) is an autonomous unmanned combat airvehicle (UCAV), for the Indian Air Force. Aeronautical Development Agency (ADA) carried out the design work on the UCAV. Details of the project are classified. The UCAV will be able to release missiles, bombs and precision-guided munitions. The programme is in its formation stage. Former DRDO chief controller for Aeronautics said in 2007, that India's combat drone would be a stealthy flying-wing c aircraft with turbofan engine and internal weapons. AURA has been define as "self-defending high-speed reconnaissance UAV with weapon firing capability" by the ADA. The AURA will cruise at medium altitude and will carry on-board sensors for targeting and weapon guidance along with two or more guided strike weapons. ADA and Defence Electronics Application Laboratory jointly developed the flight control system and data link packages of Aura(unmanned combat aerial vehicle).

6.2) PAK-FGFA (SU-57):

The **Sukhoi/HAL Fifth Generation Fighter Aircraft** (**FGFA**) or **Perspective Multi-role Fighter** (**PMF**) is a fifth-generation fighteraircraft being developed by India and Russia for use by these Nations. It is a derivative project of the Russian Sukhoi Su-57 that is being developed for the Russian Air Force. The FGFA was the earlier designation for the Indian version, while the combined project is now called the Perspective Multi-Role Fighter (PMF). There are total of 43 improvements over the Su-57, including stealth, supercruise, advanced sensors, networking and combat avionics in the completed FGFA. One prototype from Russia and one

prototype from India will be developed separately. The Indian version will be a two-seater for pilot and co-pilot/weapon systems operator (WSO). Ensuring the great success of the BrahMosproject, In early 2007 Russia and India agreed to jointly study and develop a Fifth Generation Fighter Aircraft (FGFA) programme. On 27 October 2007, Sukhoi's director Mikhail Pogosyan stated: "We will share the funding, engineering and intellectual property in a 50–50 proportion", in an interview with *Asia Times*. This aircraft is to be developed till 2025.

Figure. 6.2 INDIA'S FGFA (SU-5

6.3) HAL AMCA (Advanced Medium Combat Aircraft) :
The HAL Advanced Medium Combat Aircraft (AMCA) is an Indian programme of a fifth generation fighter aircraft. It is being developed by an aerospace industry team which consists of Hindustan Aeronautics Limited (HAL) which carried out manufacturing and the Aeronautical Development Agency (ADA) as the design firm. It is twin-engine, single-seat, stealth all weather multirole fighter aircraft. Feasibility study on AMCA and the preliminary design stage have been completed. The project awaits approval to begin design and development stage. The first flight is scheduled to occur in 2025 It is a multirole combat aircraft designed for the ground attack, air superiority, intercepting, bombing, and other types of roles. It will complement HAL Tejas, Sukhoi/HAL FGFA, the Su-30MKI, and Rafale in the air force service and HAL Naval Tejas and Mikoyan MiG-29K in the naval service. The AMCA is intended to be the successor to the SEPECAT Jaguar, Dassault Mirage 2000 and Mikoyan MiG-27in the Indian Air Force. The aircraft, along with its naval variants, is intended to provide the bulk of the manned tactical airpower of the Indian Air Force and Navy over the coming decades. AMCA would be the third supersonic jet of Indian origin after the HAL Marut and HAL Tejas.[8]

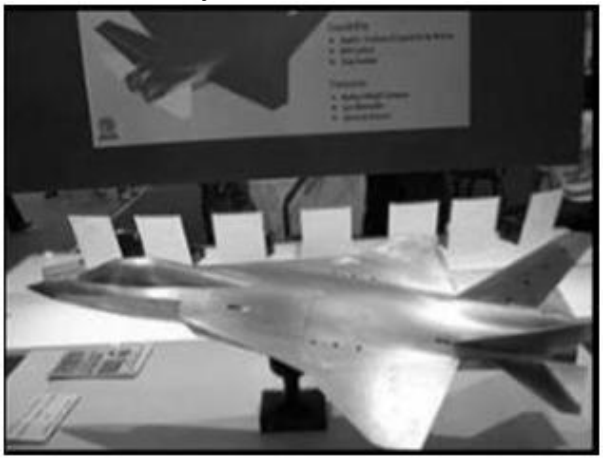


Figure.6.3 HAL AMCA

7. CONCLUSION

Stealth technology is clearly the bright future of air wars. In the future, as air defence systems grow more accurate and deadly, stealth technology makes a country more confident and obvious over their capabilities in battlefield as compared to other countries. In the future, rather than in fighters and bombers stealth technology can also use in ships, helicopters, tanks and transport planes. For a developing country like India, having multiple imminent enemies it is very necessary to have such technology. India also has taken initiative in that direction also. There is scope not only for the development of aircraft using this technology but also the huge scope for developing modified advanced RADAR systems as well as Surface to Air Missiles (SAM). After the development of this technology by America a deadly race has been started around the world to gain this technology. It's an arm race except it isn't between specific countries "It's a fight between technologies."

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