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REPORT

STEALTH TECHNOLOGY

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INTRODUCTION

Stealth or low observability (as it is scientifically known) is one of the most misunderstood and misinterpreted concepts in military aviation by the common man. Stealth aircraft are considered as invisible aircraft, which dominate the skies. With an additional boost from Hollywood action movies, stealth is today termed as the concept invincibility rather than invisibility. Though, the debate still continues on whether stealth technology can make an aircraft invincible it was found that stealth aircraft are detectable by radar.

The motive behind incorporating stealth technology in an aircraft is not just to avoid missiles being fired at is but also to give total deniability to covert operations. This is very much useful to strike targets where it is impossible to reach. Thus we can clearly say that the job of a stealth aircraft pilot is not to let others know that he was ever there.

HISTORY

In England, irregular units of gamekeepers in the 17th century were the first to adopt drab colours (common in the 16th century Irish units) as a form of camouflage, following examples from the continent. Yehudi lights were successfully employed in World War II by RAF Shorts Sunderland aircraft in attacks on U-boats. In 1945 a Grumman Avenger with Yehudi lights got within 3,000 yards (2,700 m) of a ship before being sighted. This ability was rendered obsolete by the radar of the time. The U-boat U-480 may have been the first stealth submarine. It featured a rubber coating, one layer of which contained circular air pockets to defeat ASDIC sonar. One of the earliest stealth aircraft seems to have been the Horten Ho 229 flying wing. It included carbon powder in the glue to absorb radio waves.Some prototypes were built, but it was never used in action. During the 1950s, the Avro Vulcan, a British bomber, had a remarkably small appearance on radar despite its large size, and occasionally disappeared from radar screens entirely. In 1958, the CIA requested funding for a reconnaissance aircraft, to replace U-2 spy planes in which Lockheed secured contractual rights to produce the aircraft. "Kelly" Johnson and his team at Lockheed's Skunk Works were assigned to produce the A-12 or OXCART the first of the former top secret classified Blackbird series which operated at high altitude of 70,000 to 80,000 ft and speed of Mach 3.2 to avoid radar detection. Radar absorbent material had already been introduced on U-2 spy planes, and various plane shapes had been developed in earlier prototypes named A1 to A11 to reduce its detection from radar. Later in 1964, using prior models, an optimal plane shape taking into account compactness was developed where another "Blackbird", the SR-71, was produced, surpassing prior models in both altitude of 90,000 ft and speed of Mach 3.3. The Lockheed SR-71 included a number of stealthy features, notably its canted vertical stabilizers, the use of composite materials in key locations, and the overall finish in radar absorbing paint.

During 1970s, the U.S. Department of Defence then launched a project called Have Blue to develop a stealth fighter. Bidding between both Lockheed and Northrop for the tender was fierce to secure the multi-billion dollar contract. Lockheed incorporated in its program paper written by a Soviet/Russian physicist Pyotr Ufimtsev in 1962 titled Method of Edge Waves in the Physical Theory of Diffraction, Soviet Radio, Moscow, 1962. In 1971 this book was translated into English with the same title by U.S. Air Force, Foreign Technology Division (National Air Intelligence Center), Wright-Patterson AFB, OH, 1971. Technical Report AD 733203, Defense Technical Information Center of USA, Cameron Station, Alexandria, VA, 22304-6145, USA. This theory played a critical role in the design of American stealth-aircraft F-117 and B-2. The paper was able to find whether a plane's shape design would minimise its detection by radar or its radar cross-section (RCS) using a series of equations could be used to evaluate the radar cross section of any shape. Lockheed used it to design a shape they called the Hopeless Diamond, securing contractual rights to mass produce the F-117 Nighthawk. The F-117 project began with a model called "The Hopeless Diamond" (a wordplay on the Hope Diamond) in 1975 due to its bizarre appearance. In 1977 Lockheed produced two 60% scale models under the Have Blue contract. The Have Blue program was a stealth technology demonstrator that lasted from 1976 to 1979. The success of Have Blue lead the Air Force to create the Senior Trend program which developed the F-117.

WHAT IS STEALTH?

In simple terms, stealth technology allows an aircraft to be partially invisible to Radar or any other means of detection. This doesn't allow the aircraft to be fully invisible on radar. Stealth technology cannot make the aircraft invisible to enemy or friendly radar. All it can do is to reduce the detection range or an aircraft. This is similar to the camouflage tactics used by soldiers in jungle warfare. Unless the soldier comes near you, you can't see him. Though this gives a clear and safe striking distance for the aircraft, there is still a threat from radar systems, which can detect stealth aircraft.

The Russian 1R13 radar system is very much capable of detecting the F-117 "Night Hawk" stealth fighter. There are also some other radar systems made in other countries, which are capable of detecting the F-117. During the Gulf war the Iraqis were able to detect the F-117 but failed to eliminate its threat because of lack of coordination. The most unforgettable incident involving the detection and elimination of a stealth aircraft was during the NATO air-war over Yugoslavia. This was done by a Russian built "not so advanced" SAM (possibly the SA-3 or SA-6). The SAM system presumably used optical detection for target acquisition in the case.

HOW DOES STEALTH TECHNOLOGY WORK?

The concept behind the stealth technology is very simple. As a matter of fact it is totally the principle of reflection and absorption that makes aircraft "stealthy". Deflecting the incoming radar waves into another direction and thus reducing the number of waves does this, which returns to the radar. Another concept that is followed is to absorb the incoming radar waves totally and to redirect the absorbed electromagnetic energy in another direction. What ever may be the method used, the level of stealth an aircraft can achieve depends totally on the design and the substance with which it is made of.

RAS

RAS or Radar absorbent surfaces are the surfaces on the aircraft, which can deflect the incoming radar waves and reduce the detection range. RAS works due to the angles at which the structures on the aircraft's fuselage or the fuselage itself are placed. These structures can be anything from wings to a refueling boom on the aircraft. The extensive use of RAS is clearly visible in the F-117 "Night Hawk". Due to the facets (as they are called) on the fuselage, most of the incoming radar waves are reflected to another direction. Due to these facets on the fuselage, the F-117 is a very unstable aircraft.

The concept behind the RAS is that of reflecting a light beam from a torch with a mirror. The angle at which the reflection takes place is also more important. When we consider a mirror being rotated from 0o to 90o, the amount of light that is reflected in the direction of the light beam is more. At 90o, maximum amount of light that is reflected back to same direction as the light beam's source. On the other hand when the mirror is tilted above 90o and as it proceeds to 180o, the amount of light reflected in the same direction decreases drastically.

RAM

Radar absorbent surfaces absorb the incoming radar waves rather than deflecting it in another direction. RAS totally depends on the material with which the surface of the aircraft is made. Though the composition of this material is a top secret. The F-117 extensively uses RAM to reduce its radar signature or its radar cross section. The RAS is believed to be silicon based inorganic compound. This is assumed by the information that the RAM coating on the B-2 is not water roof. This is just a supposition and may not be true. What we know is that the RAM coating over the B-2 is placed like wrapping a cloth over the plane. When radar sends a beam in the direction of the B-2, the radar waves are absorbed by the plane's surface and is redirected to another direction after it is absorbed.

IR

Another important factor that influences the stealth capability of an aircraft is the IR (infrared) signature given out by the plane. Usually planes are visible in thermal imaging systems because of the high temperature exhaust they give out. This is a great disadvantage to stealth aircraft as missiles also have IR guidance system. If reducing the radar signature of an aircraft is tough, then reducing the IR signature of the aircraft is tougher. Engines for stealth aircraft are specifically built to have a very low IR signature. The technology behind this is top secret like others in stealth aircraft. Another main aspect that reduces the IR signature of a stealth aircraft is to place the engines deep into the fuselage. This is done in stealth aircraft like the B-2, F-22 and the JSF. The IR reduction scheme used in F-117 is very much different from the others. The engines are placed deep within the aircraft like any stealth aircraft and at the outlet, a section of the fuselage deflects the exhaust to another direction. This is useful for deflecting the hot exhaust gases in another direction.

METHODS OF AVOIDING DETECTION

- There are some more methods by which planes can avoid detection. These methods do not need any hi-tech equipment to avoid detection. Some of them have been used for years together by pilots to avoid detection.
- One of the main efforts taken by designers of the stealth aircraft of today is to carry the weapons payload of the aircraft internally. This has shown that carrying weapons internally can considerably decrease the radar cross-section of the aircraft. Bombs and Missiles have a tendency to reflect the incoming radar waves to a higher extent. Providing missiles with RAM and RAS is an impossible by the cost of these things. Thus the missiles are carried in internal bombays which are opened only when the weapons are released.
- Aircraft has used another method of avoiding detection for a very long time. Radars can use the radar waves or electro-magnetic energy of planes radar and locate it. An aircraft can remain undetected just by turning the radar off.
- In case of some of the modern stealth aircraft, it uses its wingman in tandem to track its target and destroy it. It is done in the following way. The fighter, which is going to attack moves forward, the wingman (the second aircraft) on the other hand remains at a safe distance from the target which the other fighter is approaching. The wingman provides the other fighter with the radar location of the enemy aircraft by a secured IFDL (In

Flight Data Link). Thus the enemy radar is only able to detect the wingman while the attacking fighter approaches the enemy without making any sharp turns. This is done not to make any sudden variations in a stealth aircraft's radar signature.

PLASMA STEALTH

Plasma stealth technology is what can be called as "Active stealth technology" in scientific terms. This technology was first developed by the Russians. It is a milestone in the field of stealth technology. The technology behind this not at all new. The plasma thrust technology was used in the Soviet / Russian space program.

Later the same engine was used to power the American Deep Space 1 probe. In plasma stealth, the aircraft injects a stream of plasma in front of the aircraft. The plasma will cover the entire body of the fighter and will absorb most of the electromagnetic energy of the radar waves, thus making the aircraft difficult to detect. The same method is used in Magneto Hydro Dynamics. Plasma stealth will be incorporated in the MiG-35 "Super Fulcrum / Raptor Killer". This is a fighter which is an advanced derivative of the MiG-29 "Fulcrum / Baaz". Initial trials have been conducted on this technology, but most of the results have proved to be fruitful.

DETECTION METHODS FOR STEALTH AIRCRAFT

Whenever a technology is developed for military purposes, another technology is also developed to counter that technology. There are strong efforts to develop a system that can counter the low obervability of the fifth generation stealth aircraft. There are ways of detection and elimination of a low observable aircraft but this doesn't give a 100% success rageatpresent. On a radar screen, aircraft will have their radar cross sections with respect to their size. This helps the radar to identify that the radar contact it has made is an aircraft. Conventional aircraft are visible on the radar screen because of its relative size. On the other hand, the relative size of a stealth aircraft on the radar screen will be that of a large bird. A proven method to detect and destroy stealth aircraft is to triangulate its location with a network of radar systems. This was done while the F-117 was shot down during the NATO offensive over Yugoslavia. A new method of detecting low observable aircraft is just over the horizon. Scientists have found a method to detect stealth aircraft with the help of microwaves similar to the ones emitted by the cell phone towers. Nothing much is known about this technology, but the US military seems to be very keen about doing more research on this.

ADVANTAGES OF STEALTH TECHNOLOGY

1. A smaller number of stealth vehicles may replace fleet of conventional attacks vehicles with the same or increased combat efficiency. Possibly resulting in longer term savings in the military budget.
2. A Stealth vehicles strike capability may deter potential enemies from taking action and keep them in constant fear of strikes, since they can never know if the attack vehicles are already underway.
3. The production of a stealth combat vehicles design may force an opponent to pursue the same aim, possibly resulting in significant weakening of the economically inferior party.
4. Stationing stealth vehicles in a friendly country is a powerful diplomatic gesture as stealth vehicles incorporate high technology and military secrets.
5. Decreasing causality rates of the pilots and crew members.

DISADVANTAGES OF STEALTH TECHNOLOGY

1. Stealth technology has its own disadvantages like other technologies. Stealth aircraft cannot fly as fast or is not maneuverable like conventional aircraft. The F-22 and the aircraft of its category proved this wronguptoanextent.

2. Another serious disadvantage with the stealth aircraft is the reduced amount of payload it can carry. As most of the payload is carried internally in a stealth aircraft to reduce the radar signature, weapons can only occupy a less amount of space internally.

3. Whatever may be the disadvantage a stealth aircraft can have, the biggest of all disadvantages that it faces is its sheer cost. Stealth aircraft literally costs its weight in gold. Fighters in service and in development for the USAF like the B-2 ($2 billion), F-117 ($70 million) and the F-22 ($100 million) are the costliest planes in the world.

4. After the cold war, the number of B-2 bombers was reduced sharply because of its staggering price tag and maintenance charges. There is a possible solution for this problem. In the recent past the Russian design firms Sukhoi and Mikhoyan Gurevich (MiG) have developed fighters which will have a price tag similar to that of the Su-30MKI.

STEALTH AIRCRAFT OF YESTERYEARS, TODAY AND TOMORROW

Stealth technology is a concept that is not at all new. During the Second World War, allied aircraft used tin and aluminum foils in huge numbers to confuse German radar installations. This acted as a cover for allied bombers to conduct air raids. This method was later used as chaffs by aircrafts to dodge radar guided missiles. The first stealth aircraft was the F-117 developed by Lockheed Martin. It was a top-secret project developed by its Skunk Works unit. The F-117 was only revealed during the late 80s and then saw action in the Persian Gulf. In due course of time the B-2 was developed as a successor to the B-2. Though both of them serve different purposes, the B-2 went a step ahead of the F-117. The B-2 was developed to deliver nuclear weapons and other guided and unguided bombs. Another stealth aircraft, which made a lot of promises and in the end ended up in a trashcan, was the A-12. It was a fighter that was designed to replace the F-14 and F-18 in the future. The capabilities of this aircraft were boasted to such an extent that the project ended up in a big mess. Stealth technology became famous with the ATF contest. The Boeing-Lockheed YF-22 and the McDonell Douglas-Grumman YF-23 fought for the milti-billion contract to build the fighter that would take the USAF into the fifth generation fighter era. merica now has a competitors, Russia decided to respond to the development of the F-22 by making the Su-47 (S-37) "Berkut" and the MiG-35 "Super Fulcrum / Raptor Killer". These fighters were developed by the two leading aviation firms in Russia Sukhoi and Mikhoyan Gurevich (MiG). The future of these projects totally depends on the funding which will be provided to the Russian defense sector. There are some hopes of increase in the funding to these projects as countries like India have started providing funds and technical assistance for these projects.
Another competition that soon came into the spotlight after the ATF competition was the JSF. This time Boeing developed the X-32 and the Lockheed martinh. its X-35. With the experience gained from developing the F-22, they were tasked with making a replacement for the F-16. This saw great technological advances, as they had to make the first operational supersonic VSOL aircraft. Lockheed martin took the technical assistance of Russian scientists who developed the Yak-141. TheYak-141 is the first supersonic VSTOL aircraft. Many projects remain over the horizon that will use stealth technology as its primary capability. They come from some of the most unlikely contenders. These projects include the Euro JSF, which will be designed by the team that developed the EF-2000. Russia is stepping forward with its LFS project with the S-54 and other designs. Two new entries into this field will be India and China. India will be introducing its MCA, which is a twin engine fighter without vertical stabilizers.

FUTURE OF STEALTH TECHNOLOGY

Stealth technology is clearly the future of air combat. In the future, as air defense systems grow more accurate and deadly, stealth technology can be a factor for a decisive by a country over the other. In the future, stealth technology will not only be incorporated in fighters and bombers but also in ships, helicopters, tanks and transport planes. These are evident from theRAH-66 "Comanche" and the Sea Shadow stealth ship. Ever since the Wright brothers flew the first powered flight, the advancements in this particular field of technology has seen staggering heights. Stealth technology is just one of the advancements that we have seen. In due course of time we can see many improvements in the field of military aviation which would one-day even make stealth technology obsolete

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