WITH the advent of the First World War in the early 20th century, defense technology began advancing at a great pace. All countries involved in this devastating war started stepping up their technologies in order to outsmart and in turn defeat their enemies.

Aviation technology was also revolutionized as nations realized the potential of an aerial attack which has the capacity to devastate the morale of people and can easily inhibit the war effort by eliminating strategically important targets such as industrial parks. Consequently, detecting such enemy aircraft assumed importance as a defensive system.

After the First World War, many nations secretly started developing and researching on the radar and its potential use as an early warning system before the actual attack took place. Research on radar technology rapidly continued throughout the war years and the British were the first to use radar as a defensive measure to detect incoming enemy aircraft during the Battle of Britain in 1940.

This rapid growth of radar technology was subsequently countered by stealth technology which could make aircraft virtually undetectable to radars. One of the first aircraft on which this technology was put to practice was the Horten Ho 229. The aircraft was a flying wing design and its employment of charcoal with the wood glue of the airplane made it absorb radio waves.

A stealth aircraft’s primary job is to complete its mission undetected by its enemy. Modern stealth aircraft employ various methods to reduce their radar and infrared signatures. Stealth bomber aircraft like the Northrop Grumman B-2 Spirit, which is capable of delivering nuclear weapons, become virtually invisible to radar detection by having a very negligible signature.

The primary factor in a stealth aircraft is its design. Stealth aircraft are designed to decrease their radar cross section so that the waves that are transmitted towards the aircraft are either absorbed or are largely deflected. A stealth aircraft avoids rounded aerodynamic surfaces which are unable to deflect radio waves transmitted perpendicularly on its surface thus compromising its position.

Stealth aircraft also absorb radar signatures by usage of RAM or Radar Absorbent Material. Although most Radar Absorbent Material are classified, the most common type of Radar Absorbent Material that was used in early stealth aircraft such as the Lockheed Martin F-117 Blackbird was “Iron Ball Paint”. In this process, the aircraft’s surface is painted with tiny metallic spheres coated with ferrite. When radar waves fall on this surface, they cause molecular oscillations in these spheres thus turning the incident radar energy into heat which is dissipated.

The design of a stealth aircraft has also to deal with protrusions that can compromise its stealth. Thus, all modern stealth aircraft mostly store their entire payload inside their wing or fuselage which is only compromised when it discharges its weapon to attack its target. Aircraft engines are often set within the fuselage which reduces radar signature.

Of the earlier stealth aircraft, the Lockheed SR-71 Blackbird utilized composite materials in strategically important locations and had canted vertical stabilizers along with Radar Absorbent paint to significantly reduce its radar cross section although it mainly relied on its high cruising altitude and its supersonic speed.

Lockheed Martin F-117 Nighthawk was the first military stealth aircraft to come under service, but its radical design to counter radar waves made it aerodynamically unstable and thus it could not be controlled without fly-by-wire controls.

With the advent of thrust vectoring technology and advanced avionics, stealth fighter aircraft like the Lockheed Martin F-22 Raptor gained greater...
maneuverability along with stealth technology which gave them a greater edge over conventional fighter aircraft. The Raptor can also conduct small bombing missions virtually undetected, thus also claiming greater versatility over conventional fighter-bombers.

All stealth aircraft have a radical design as compared to other conventional aircraft. The Northrop Grumman B-2 Spirit is a flying wing design which uses split rudders as it has no distinct empennage. The Lockheed Martin F-35 Lightning II also incorporated V/STOL capability (Vertical/Short Take Off and Landing) along with its stealth and thus has achieved even greater versatility as it needs very less space to operate from. Aircraft like the F-35 Lightning and F-22 Raptor use planform alignment, which involves using small number of surface orientations in the shape of its structure to avoid radar detection while corner reflections of radar waves are reduced by aircraft like F-117 Nighthawk by tilting their tail surface or as in case of the B-2 Spirit, a presence of a vertical stabilizer is completely eradicated.

Along with radar, aircraft were also detectable by infrared rays and thus to keep the title of being a stealth aircraft, engine exhausts of early stealth aircrafts were set in the fuselage like that of the B-2 Spirit. The exhaust is thereby cooled by the air following the surface of the wing. Also positioning fuel lines or tanks near the exhaust makes them act as heat absorbers thus reducing infrared signature.

Stealth aircraft have a great aerial advantage over conventional aircraft as they can penetrate deep into enemy territory without being detected and thus reduce life risk factor for the pilots. Also with the major involvement of computer systems in the cockpits of modern aircraft, a lot of work can be done easier and quicker thus making it possible for as little as four people to successfully complete a mission which would previously require more crew and support aircraft.

In spite of having an upper hand in modern aerial warfare, stealth aircraft do have a few limitations. They utilize a variety of composite and radar absorbent material to inhibit detection by infrared and radar. However, aircraft that have radar absorbent skin are comparatively sensitive than conventional aircraft skins.

Stealth aircraft also spend a long time on the assembly line before they are finally finished and are much more expensive than conventional military aircraft. Aerodynamic instabilities also often bothered aircraft like the F-117 Nighthawk and the B-2 Spirit which would have been highly instable to control without the constant corrections by the digital fly-by-wire control system onboard the aircraft. They also lacked afterburners which were necessary to give them an extra boost of thrust for speed as it would make them susceptible to infrared detection by the heat emitted. However, with the utilization of modern design techniques, this has been avoided in newer stealth aircrafts like the F-22 Raptor and the F-35 Lightning which are now able to incorporate afterburners like conventional fighter aircrafts.

Stealth aircraft can also give away their position due to externally mounted payloads which cannot be stored internally inside the aircraft as their internal payload capacity is quite reduced due to design considerations.

Modern stealth aircraft, especially stealth fighter aircraft have overcome these shortcomings due to more advanced design techniques and avionic technologies. Stealth aircraft also give military operators the element of surprise. The F-22 and F-35 can conduct strikes at supersonic speeds under the full cover of stealth minimising loss of human life as systems on board can pinpoint targets and destroy them without causing damage to the surroundings. Pilots operating inside stealth aircraft feel a lot safer than while conducting missions on conventional aircraft as they can accomplish their mission undetected by the enemy.

Even though stealth aircraft are undoubtedly one of the greatest military aviation technologies that the world has come up with, we just hope we do not get to see them in action on real battlefields.

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