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The Principles of an Intelligent Stealth Technology: A Detailed Study

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Abstract

Stealth is a magic word in cutting edge modern weapons. Able to strike with impunity, stealth aircraft and warships are virtually invisible to most types of military sensors. Although stealth isn't invulnerable to detection, its benefits are inherently obvious. Many different components are juggled to make stealth aircraft work. This paper shows the principles of stealth technology.

Keywords: *Aircraft, principle, stealth, surfaces, technology*

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INTRODUCTION

Stealth is more a complicated mix of special materials and technologies designed to reduce the ability of the opposition to detect, track and attack the aircraft or warship. Stealth technology covers a range of techniques used with aircraft, ships and missiles, in order to make them less visible to radar and other detection methods[1]. Stealth aircraft are primarily designed to minimize frontal radar cross section. It is impossible to design an aircraft able to reduce radar cross section equally in all directions, making detection easier from the side or above [2]. Moreover, certain sorts of radar and infrared tracking devices can identify stealth aircraft better than traditional radar apparatus. Stealth aircraft are constructed to either absorb or misdirect for all intents and purposes the greater part of any radar waves they interact with, in this way totally inactivating the rival's capability to obtain an exact interpretation on the characteristics of the aircraft. Innovative materials absorb majority of the radar's signal, and the overall shape of the craft redirects approximately all the remaining waves away from the recipient [3]. Various different components are manipulated to make stealth aircraft function. Special radar absorbent materials, concealed engines, flawlessly smooth surfaces, color, unique architecture, and ordinance, and electronic counter measures all combine to enable stealth aircraft to get the better off the most recent defense abilities.

HISTORICAL BACKGROUNDS

Radar avoidance technology was first used on a large scale during the Gulf War in 1991. However, F-117A Stealth Fighters were used for the first time in combat during Operation Just Cause in 1989. Since then it has become less effective due to developments in the algorithms used to process the data received by radars, such as Bayesian particle filter methods [3]. Increased understanding of stealth vehicles and the technologies behind them is encouraging the advancement of technologies for detecting stealth vehicles, like low-frequency radars and passive radar arrays. Many countries however go on with developing the stealth vehicles [4]. The concept of stealth itself is not novel. Being able to operate without the

knowledge of the opponent has always been a goal of military technology and techniques. But "stealth technology" redesigns the vehicle itself to dramatically reduce its observability. A mission using stealth will obviously become common knowledge eventually, such as when the target is destroyed. But if the attacking force maximizes stealth and speed, it can also gain the element of surprise. Attacking with surprise gives the attacker more time to perform its mission and exit before the defending force can counter-attack [6]. With stealth technology the defender might not be able to respond at all. If a surface-to-air missile battery defending a target observes a bomb falling and surmises that there must be a stealth aircraft in the vicinity, for example, it is still unable to respond if it cannot get a lock on the aircraft in order to feed guidance information to its missiles.

Principle of Stealth Technology

The Principle of the stealth technology is as follows [7]

1. Vehicle shape
2. Internal structure
3. Color
4. Special radar absorbent material
5. Concealed engines and ordinance
6. Electronic counter measures

Vehicle Shape

The most efficient way to reflect radar waves back to the transmitting radar is with two metal plates at right angles to one another (corner reflector), perpendicular to the incident radar wave. This configuration occurs in the tail of a conventional aircraft, where the vertical and horizontal components of the tail are set at right angles. A stealth aircraft must use a different arrangement [8]. Often, a stealth design has the vertical element of the tail tipped at an angle, as in the F-117. The most radical approach is to eliminate the tail completely, as in the B-2 Spirit. As well as altering the tail, stealth design must bury the engines within the wing or fuselage, or in some cases where stealth is applied to an existing aircraft, install baffles in the air intakes, so that the turbine blades are not visible to radar. The shape of the aircraft must be devoid of complex bumps or protrusions of any kind if it is to be stealthy. This means that all weapons, fuel tanks, and other stores may not be carried on under wing pylons but must be stored internally. Furthermore, a stealth aircraft becomes unstealthy when it opens its bomb bay doors. Stealth airframes sometimes display distinctive serrations on some exposed edges, such as the engine ports.

Internal Structure and Colors

Internal structure is so designed that either the radar waves loose its energy or deflected in other direction. Stealth aircraft are typically painted in dark colors and frequently fly at night to make visual identification more difficult.

Special Radar Absorbent Material

Use of non-metallic materials called composites for the airframe. Composites are transparent to radar, whereas metals reflect waves back to the radar transmitter if the metal happens to be perpendicular to the radar, or else the metal is involved in an unstealthy shape [7]. If metals are to be used, some elements and alloys reflect less electromagnetic radiation than others. The composites used often contain high amount of ferrites as filling.

Radar absorbing paint, coating, especially on the edges of metal surfaces. The RAM coating, known also as iron ball paint, contains tiny spheres coated with carbonyl iron ferrite. Radar waves induce alternating magnetic field in this material, which leads to conversion of their energy into heat. Early versions of F-117A planes were covered with neoprene-like tiles with ferrite grains embedded in the polymer matrix, current models have RAM paint

applied directly. The aircraft must be painted by robots, because the solvent used is highly toxic [6]. In a similar vein, it is known that coating the cockpit window with a thin film of gold helps to reduce the aircraft's radar profile because radar waves would normally enter the cockpit, bounce off something random (the inside of the cockpit has a very complex shape), and possibly return to the radar - but if the gold reflects the incoming radar waves, most of the energy is likely to go straight up rather than back to the radar.

Concealed Engines and Ordinance

Technologies to reduce other signatures such as infra-red, visible, and sonic. Stealth aircraft need to stay subsonic to avoid being tracked by sonic boom. Some early stealth observation aircraft utilized very slow-turning propellers in order to be able to orbit above enemy troops without being heard. Most stealth aircraft use matte paint and dark colors, and operate only at night. Lately, interest on daylight Stealth has emphasized the use of gray paint in disruptive schemes.

CONCLUSION

This paper presents the principle of stealth technology and the stealth is clearly the future of air combat. In the future, as air defense capabilities grow more accurate and deadly, stealth can be a factor for a decisive victory by one country over another. In the future, stealth will not only be incorporated in fighters and bombers but also in ships, helicopters, tanks and transport planes. Ever since the Wright brothers flew the first powered flight.

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