Welcome
Stealth TECHNOLOGY

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What’s Stealth Technology?

✓ According to the “Oxford” Dictionary states that “Stealth”- Secret procedure or manner.

✓ And the Wikipedia describes “Stealth Technology” as “Stealth technology covers a range of techniques used with aircrafts, ships and missiles, in order to make them less visible (ideally invisible) to radar and other detection methods.

✓ **Stealth technology** allows a Machine to be partially invisible to any means of detection. All it does is reduce the detection range. This is similar to the camouflage tactics used by soldiers in jungle warfare.

✓ Stealth Technology aims in minimizing transmitted and reflected energies- heat, light, sound, electric potentials etc- to deny an opponent to locate, track, identify and attack its target.
History Of Stealth Technology

The concept of Stealth is not at all new. In Second World War allied aircrafts used tin and aluminum in huge amount to confuse German RADARS. Two prototypes were built to study and test low observability—better known as Stealth technology in 1970’s. First ever working Stealth Aircraft was developed by Lockheed Martin in 1983 called the F-117A nicknamed as the “Nighthawk”. First Stealth Ship was developed by Defense Advanced Research Project Agency, US Navy and Lockheed combined in 1985 called the “Sea Shadow(IX-529)” but was never commissioned.
What's Signature

- Signature - Any unique indicator of the presence of certain materiel or troops; especially the characteristic electronic emissions given off by a certain type of vehicle, radar, radio, or unit
Types of Signature

Signature can be caused due to reflection of incident radiation or due to emission of radiation of the vehicle due to various reasons. They can be classified as follows.

i. Radar Signature: detecting the reflection of an incident radar beam called RADAR CROSS SECTION (RCS).

ii. Infrared (IR) Signature: Emission of infrared radiations by hot parts of the vehicle.

iii. Acoustic Signature: Detection of sound emitted from the body. Using of SONAR comes under this category.

iv. Visible Signature: Detection of the vehicle by the naked eye or devices like cameras, night vision devices, etc.

v. LIDAR Signature: Same as Radar but uses a laser in place of the radar beam. Image of objects called Laser Cross Section.
Need of Stealth Technology

✓ Being able to operate without the knowledge of the enemy has always been a goal of military technology and techniques. But "stealth technology" redesigns the vehicle itself to dramatically reduce its signature.

✓ With the ever increasing development in the field of defense mechanisms like radar fused shells, IR guided “fire and forget” missiles etc, it was very dangerous to step into battle fields with advanced yet detectible machinery.

✓ Thus the development of Stealth Technology provides an edge over the advancing “Defense Mechanisms”.
Detection Methods and The Fields Used

- RCS: Aircrafts, Missiles, Ships, Land Vehicles.
- Infrared signature: Aircrafts, Missiles, Ships, Land Vehicles, Submarines.
- Acoustic Signature: Predominantly for Submarines (SONAR), Ships, Aircrafts.
- Visible Signature: Predominantly for Land Vehicles, Aircrafts, Ships.
- Laser Cross Section: Aircrafts, Missiles, Ships, Land Vehicles.
- Magnetic Signature: Submarines, Ships.
**RADAR Cross Section**

- Projected area of an equivalent reflector having uniform properties in all direction. The equivalent reflector is considered as a sphere that reflects the unit solid angle as an aircraft, ship etc..

- Represented by “s” and unit is $m^2$.

- $s = 4\pi A^2 l \omega^2$ here; $A$=Area of exposed body,
  
  $l$= Length,

  $p$= Radar reflectivity (material specific),

  $\omega$= Wavelength of the incident radar wave.

- Actual RCS depends on Angle of Incidence and Reflection and many other factors.
Infrared Signature

- Infrared radiations commonly called infrared (IR) is generated by the vibration and rotation of atoms and molecules within any material whose temperature is above 0K.

- Radiation emitted \( (e) = \varepsilon \sigma T^4 \),

  \( \sigma = \) Stefen Boltzman's constant = \( 5.67 \times 10^{-8} \) W/m\(^2\)K\(^4\)

  \( \varepsilon = \) Emissivity of the body

  \( T = \) Temperature of the body

- As temperature increases “e” per unit area increases as its fourth power. Increasing the chance to be detected heavily.

- IR signature is measured by comparing the IR map of body with neutral environment or background.
Visual Signature

- The visibility of the vehicle by any means like that of naked eyes or cameras or Night vision etc.
- Its said to be the most difficult one to eliminate and to be researched over on Air and Water fields
- Its the most easily and widely adapted "Stealth" measure for land units.
- For Submarines Except in some special cases will never be visible with naked eyes.
- Thus can be concluded as a measure for evading the enemy's eyes.
**LASER Cross Section (LRCS)**

- The measurement of signature developed by LIDAR is called LASER Cross Section (LRCS).
- This has been widely considered as a unique RADAR mechanism.
- Lidar uses Laser in place of RADAR waves in RADAR.
- Combines Photoelectric and Traditional Detection methods.
- High detection efficiency than RADAR due to the use of LASER. As they have shorter wavelengths, the beam quality is high.
- LRCS is a complex function of target dynamics and static features.
The Route to STEALTH

Stealth comes in several levels

First Level: Low signature improve the performance of onboard sensors; with no local interference caused, the component sensors are better able to read the local situation.

Second Level: Low signatures are more easily concealed by active and passive countermeasures like jammers, chaffs, flares etc..

Final Level: Reduction in signature to reach environmental backgrounds. Eg, reduction of RCS of Aircraft to a Bird or Warship to a Sea Clutter.

The best example is of the F-117A (Nighthawk) which is 19.4m long and 23625 kg in mass has an RCS of a 1.5 cm, 6 gram bumble bee.
Common Stealth Methods

• Some methods of stealth are the same for all field like reducing RCS and Visual signature.
• Although they may have some specific methods too..
• Some of the Common Methods Are as Follows
Reducing RCS (by reflection)

Vehicle Shape or Body Shape

- Avoiding right angles between surfaces.
- Metal plates meet orthogonally at junction forming corner reflectors.
- Re-entrant triangles behind their Skin, so that radar penetrating through by bouncing off the walls.
- The design is new and varied from conventional, hence attracts large amount of research.
RCS Reduction (Coatings And Absorbers)

- Radar Absorbent Surfaces (RAS)
  - Work by deflecting the incoming RADAR waves.
  - Work's due to angles on the structure mounted.
  - Scatters the Incident RADAR waves.

- Chemical composition is kept secret but known to be a silicon-based organic compound.
- Reduces detection range.
RCS Reduction (Coatings And Absorbers)

- Radar Absorbent Material (RAM)
  - Absorbs incident RADAR waves.
  - The absorption of a particular frequency RADAR depends upon the composition of RAM.
  - None can absorb RADAR of all frequency.

They may be:

I. Iron Ball Paint.
II. Foam Absorbers.
III. Jumann Absorbers.
Ariel Stealth Technology Deals With the specific Stealth Technologies used for Aircrafts And Missiles.
RCS And LRCS Reduction (Aircrafts And Missiles)

Plasma Stealth Technology.

- Plasma is a mix of ions at quasi-neutral state.
- Theoretically, Plasma interacts strongly with the electromagnetic radiations either absorbing or modulating the latter. This depends upon the temperature and density of plasma.
- Thus theoretically wrapping the frame of the object with plasma RCS and LRCS can be reduced.
- Technology said to be tested in Sukhoi-47.
Visual Signature reduction (Aircrafts And Missiles)

- Aircraft's may be painted black to fly during night for camouflage, Eg F-117 conducted all missions during night hence called the “Nighthawk”.

- Research is being conducted for day time Visual Stealth by using paints or polymers.

- News that a new skin is being tested at groom lake Facility Area 51 in Nevada that's a composite of electromagnetic conductive polyannaline for Day Stealth
IR signature reduction (Aircrafts)

- Practically impossible to eliminate IR signature.
- Use of turbofans to reduce EGT.
- Perfecting the Airframe Structure to eliminate Aerodynamic Heating.
- Exhaust Gas from Engine mixed with the cool air from surroundings to reduce plume signature.
- Reduce the use of Afterburners whose signature stands out after its usage in the Mapped IR signature.
- Use Chaff's or flares to distract the IR guided missiles.

An infrared-guided missile locks onto a bright heat source in a certain band of wavelengths. Aircraft engine nozzles are especially attractive targets.
Acoustic Signature (Aircraft's)

- Reduce the chance of being detected by the enemy by being “heard” by the enemy
- Early stealth observation aircraft's used a slow turning propeller to reduce noise.
- Avoiding Supersonic Cruises that will cause Sonic Booms

Acoustic signature is not a major driver of Aircraft
**IR Signature reduction (Missiles)**

- Use of more effective Ram jet engine.
- Reducing aerodynamic heating by improving the aerodynamic design.
- Using materials of low heat absorbing capacity, so as to reduce the signature of the missile.

The IR signature of missiles especially long Range missiles like the Inter Continental Ballistic Missiles (ICBM’s) should be considerably reduced to avoid detection and hence to be nullified.
Stealth In Land Arena
Deals with Stealth Technologies that are specific for Land vehicles
Visual Signature Reduction (Camouflage and decoys)

Camouflage

- Disrupts the character shape of the vehicle.
- Reduces shine.
- Make the vehicle difficult to identify even if spotted.
- Uses nets, paints, grille etc..

Decoys

- They provide false information about the presence of a target
- Used widely during second world war as Rubber tanks to fake the enemy by Germans
Naval Stealth Technology

Deal's with Specific Stealth Technology used in Naval field
Magnetic Signature reduction (Ships And Submarines)

• Vessel's traveling on water or under water cause disturbance in earth's magnetic field.

• Reduced by counter magnetic field of suitable strength and direction based on prior knowledge of the vessel.

• Vessel's material or hull should be made of non-magnetic material.

• Ad on board de-gausser takes care of the exception - some material's made of magnetic material.
IR Signature reduction (Ships And Submarines)

- No Hot or Cold Spot's should stand out in the temperature neutral environment
- Exhaust of the engine should be well cooled.
- Material of the vessel should be almost thermo-insulating.
- Smooth flow of the vessel should be ensured with no possible friction or cavitations that causes excess temperature gradient.
AWCT (Ship)

- AWCT- Adaptive Water Curtain Technology.
- Deflects and scatters RADAR waves thus reducing RCS.
- Conductive Sea water sprayed around the ship in a unique way creating an angled reflecting curtain.
- Reduces IR signature by using pre-cooled water.
- Reduces Visual Signature.
- Can mimic Sea Clutter.
Acoustic Signature reduction (Ships)

- Low acoustic signature by water jets, that generate much less noise than propellers.
- They are covered by sound adsorbing hood's that ensures the escape pf much less noise than what's produced.
- The vibrations of the hull need be reduced and pumps, fans mounted in such a way that they have their natural vibrations damped.
Future of Stealth Technology.

• The future of Stealth Technology seems to be brighter than ever because of the fact of significant development in the field of defense.

• The need of Stealth technology cam be stressed upon the fact that most countries are investing heavily in them and the emerging technologies are being considered seriously and being incorporated once their worth is proved.
Conclusion

The Detection and Stealth Technology has improved significantly more advanced in the last fifty years or so. This trend is likely to continue as these two oppose each other.

Its an arm race except it isn't between specific countries. “It's a fight between Technologies”.
Limitations?

- Instability of design.
- Dog fighting ability.
- **Vulnerable modes of flight.**
- Cost of Maintenance and Operations
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Thank you
Questions