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Review Paper on Technology of Fifth Generation Jets

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ABSTRACT

In this paper, we will discuss the basic concept of fifth generation fighter planes and technology used in developing such planes. Also, we will discuss how the concept of fifth generation jets came into being and how they are better in technology than fourth generation planes. Lastly, we will discuss about various development programs of fifth generation jets undertaken by various nations of world.

General Terms

General terms associated with this paper are as under:

RAM: Radar absorbing material

SAM: Surface to Air Missile

IRST: Infra-red search and track

RCA: Radar cross-sectional area

RCS: Radar cross-section

Keywords

F-117Nighthawk, stealth jets, stealth fighter jets, F-22Raptor, F-35 Joint Strike Fighter, AMCA, J-20, Su-57

1. INTRODUCTION

Since the end of WWII the world has been embroiled in somewhat called a situation to outmaneuver other nation in terms of economic development, infrastructure development, social factors and among these factors a factor which is considered most important among for a nation to take proud among itself is really the factor of how strong is its defense and it's defense forces but more importantly is the factor of how much offensive a nation does possess. But from early the start of 19th century man learnt a lesson how to outperform his enemy and that was in compounding in striking power ,mobility and self-protection. These all things were performed by the so called "fighter jets" or "bombers" which have remained a backbone of strong forces around the world. Since the backbone of the entire world's big players who struggle for power and they remain a prime target among military enthusiasts all over the world.

2. CONCEPT DEVELOPMENT

The development of fifth generation jets started during the period of cold war as a result of effort to make Soviet Union's air defense which was best in the world literally ineffective. After development of fifth generation jets United States plan was to dominate Soviet airspace in case hostilities break out. Initially the development was so secretive that Pentagon refused to even admit such a program exists. The first to develop under this program was F-117 Nighthawk developed by Lockheed Martin. The plane was developed on stealth geometry which means that special focus was on geometry of the plane rather than special RAM used today.

Fig. F-117Nighthawk

But on 27 March 1999, something happened which changed the whole concept of stealth jets that they were invisible to enemy radars. On that day an F-117 was shot down by Yugoslav army unit using obsolete SAM system of low frequency.

2.1 Development of new concept

After 1999 incident the concept and thinking about the stealth jets changed. Before that they were said to be invisible to radars .After that incident the whole focus was changed into the material used for making such planes but even such that jets are not considered totally invisible but can be tracked partially by low frequency radars and IRST systems. Even the new fighters jets like f 35joint strike fighter is not stealthy at all sides.F-35 is stealthy from X-band radars from front and rear, from S-band radars it is stealthy from the narrow front aspect only but against L-band radars it reduces its RCA from direct front only.

2.2 Dependence on RAM and RCS

The most important factor affecting the RCS is the geometry 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

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from an expected radar antenna and not back to it. Most of fifth generation fighter jets have dependence on RAM or material which deflects the radar signals instead of reflecting it back. The downing of F-119 changed that stealth jets not only needed stealth geometry but special materials for their structure. Several techniques have been suggested for RCS reduction. They are: (i) Shaping, (ii) active loading, (iii) discrete (passive) loading, (iv) Distributing loading.

The RCS depends on following equation:

$$R_{max} = \sqrt[4]{\frac{P_t\, G\, A_e\, \sigma}{(4\pi)^2\, S_{min}}}$$

Where R_{max} is the maximum detection range, the transmission power, and the gain and the effective area of the transmitting and receiving antennae (which coincide in the monostatic radar), is the RCS of the target and the minimum detectable signal.

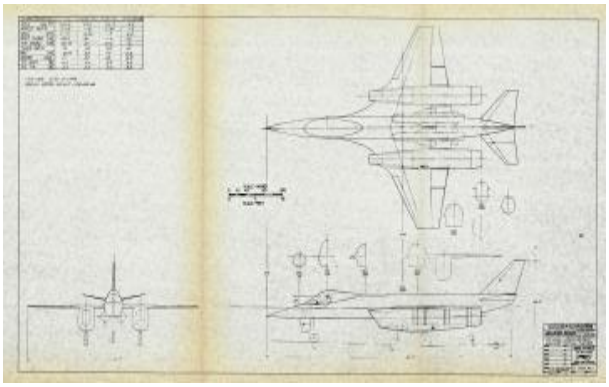

Fig.F-22 Raptor Design for RCS

3. IMPROVEMENTS OVER 4TH GEN. JETS

3.1.1 Key Attributes of 5th Gen. Fighters

- Stealth
- Minimize susceptibility to SAMs
- *Engage air threats before detection*
- *Maneuverability*
- *Maintain parity / dominate Air-to-Air and Air-to-Ground engagements*
- *Multi-Role vAir-to-Air and Air-to-Ground*
- *Aircraft "exclusive domains" defined by areas of optimized performance and unique capabilities*
- *Fused Sensors & Avionics*
- *Synergistic integration of information*

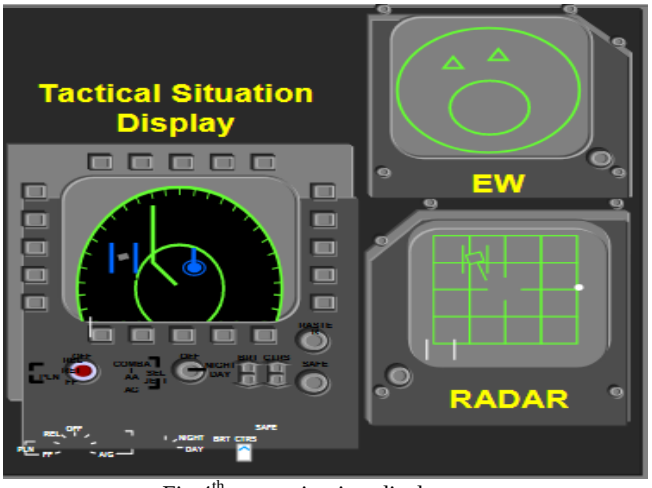

Fig.4th generation jets display

Fig.5th generation jets display

It is worth to note here that technicians of fifth generation jets are trained in such a way that they have to coat the jets with RAM such that the jets don't lose their radar deflection coating because after their sorties the jets may get covered with dust or other material thus comprising their stealth character.

4. VARIOUS STEALTH JETS:

4.1 F-22 Raptor

- Twin engine
- Single Seater
- Air to Air Specialized
- Unit Cost Approx. 150 million USD
- Developed by Lockheed Martin for USAF

Note: US Congress passed law preventing its export because of high end secretive technology

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Fig. F-22 Raptor

4.2 F-35

- Developed by Lockheed Martin for US and other allied& partners of US under "Joint Strike Fighter Programme"
- Comes in three variants
  - i) F-35 A
  - ii) F-35 B
  - iii) F-35 C

Each variant to three branches of military: Air force, Navy, Marine.

- Per Unit Cost:85 to 125 million USD
- Proposed to one of mass produced jets by 2040s


Fig.F-35

4.3 Su-57

- Designed by Sukhoi Bureau
- None of details out yet since it is in testing phase yet.


Fig.Su-57

4.4 J-20

- Developed by Chengdu Aerospace of China
- Said to be copy of F-22 & F-35 of which designed were stolen through cyber espionage


Fig.J-20

4.5 Various other developments

Other nations like India's AMCA programme are design phase and lot of work is to be done in this field.

5. CONCLUSION

A lot of work is to be done in this field because even the developed one like F-35 have revealed design flaws and is undergoing retrofitting to make them a genuine success. Since defense sector is one of largest research oriented sector so research and capital is required to make it worth for everybody to love aviation.

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