Russian fighter technology accelerates

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RUSSIA'S military aircraft manufacturing industry has well and truly recovered from the slump following the collapse of the Soviet Union two decades ago. With the first public disclosures a year ago of the Sukhoi T-50 PAK-FA stealth fighter the industry is yet again creating designs at the forefront of fighter technology. Sukhoi is today one of the world's most active manufacturers of combat aircraft, with a genuinely global customer base catering to nations that do not qualify or will not purchase US and EU built products, or who prefer the less politically restrictive terms of Russian sales. While China's reverse engineering of two Flanker variants has produced considerable public controversy in Russia, Sukhoi continues to market more recent Flankers to the PLA. With the stealthy PAK-FA now planned as a replacement for domestic and export Flankers, the proliferation problem observed with the Flanker is set to further expand over this decade.

T-50 PAK-FA

The stealthy T-50 PAK-FA or Perspektivniy Aviatsioniy Komplex Frontovoy Aviatsii [Future Tactical Air System] was devised from the outset to be a multirole high performance replacement for the Flanker family of fighters, intended for both the Russian Air Force and foreign export clientele. India engaged early in the program and will contribute major portions of the weapon system software. The Indian FGFA variant is intended to be a dual tandem seat derivative of the Russian single seat design.

When images and video of the T-50 PAK-FA appeared in the Russian media many US observers labelled the aircraft an F-22-ski. Much more detailed analysis (http://www.ausairpower.net/APA-2010-01.html) shows otherwise, and indicates important advances in aerodynamic and control system design. By US definitions, a mature production PAK-FA would qualify as a Low Observable or Very Low Observable design.

A major problem observable in many if not most analyses of the PAK-FA (and more recently China's J-20) has been 'mirroring', or making assumptions about foreign development methodology, design reasoning and design definition based upon Western, especially US practices. This is more than often pure folly, since Russian industry follows quite different strategies in prototyping and progressive development based upon very disciplined risk management and incremental expansion. Many of the claims made about the stealth capability of the T-50 in the US amount to simple misinterpretation, resulting from a failure to study past Russian practices.

The T-50 is a large fighter, comparable in size to the Flanker, F-15 and F-22. Russian sources have indicated an internal fuel capacity of the order of 25,000 lb, to provide exceptional unrefuelled subsonic range, and high supersonic persistence.

The prototype T-50 aircraft are fitted with the early production -117S engine developed for the Su-35S. It uses core components from the AI-41F supercruise engine, itself developed for the cancelled MiG MFI delta-canard supercruiser along with an improved fan and other components from the standard AI-31F Flanker engine. The -117S engine will permit supersonic cruise but it is not the intended production engine for the T-50. The latter is currently in development, and is intended to match or better the Pratt & Whitney F119-PW-100 used in the F-22.

The most prominent feature of the T-50 is its shaping, which is without dispute intended to provide a genuine stealth capability in the forward hemisphere, and possibly also in the aft hemisphere.

The planform of the T-50 is edge aligned, in the manner of most US stealth aircraft. This is intended to place reflections from the leading and trailing edges of the wings and tail surfaces, and the inlet strake, into very specific and narrow common lobes.

The forward fuselage of the T-50 is chined, in a manner very similar to the F-22, the intent being to reflect upward and downward any impinging radiation in the plane of the aircraft's flight, and to modest angles above and below same.

The inlet leading edges are also edge aligned, in a

manner which fuses ideas used in the F-22A and YF-23A. The widely spaced inlet tunnels provide an outward S-bend to increase reflection losses in an absorber coated tunnel. Much more interesting is the careful faceting of the engine nacelles, which is designed to remove the specular reflections seen with the Flanker or F-14 nacelle geometries, this idea being borrowed from the YF-23A.

The wing/fuselage join is generally well sculpted, and intended to remove the corner reflector between the wing and fuselage. The lower fuselage tunnel will produce similar unwanted effects to the sculpted lower fuselage of the F-35.

The aft quadrant of the T-50 presents interesting questions. The current prototype configuration exhibits the very same vice as the F-35, which is the use of circular or axi-symmetric engine nozzles, the anti-thesis of good stealth design. Moreover the rounded aft engine nacelles 'undo' much of the good effect produced by the chined centre afterbody and faceted forward nacelles. This suggests that the prototypes are not using the final nozzle or aft nacelle design, and we should not be surprised to see F-22 style nozzles appear later in development, as the production engine is introduced.

An overall assessment is that the T-50 prototype stealth shaping has all of the vices of the stealth shaping in the F-35, as a result of which application of mature absorbent materials and other stealth measures in a production design would produce similar stealth performance to the F-35, which is inferior to the F-22A Raptor in key aspects.

What is clear is that the T-50 prototypes are intended to prove aerodynamics and systems, and we will not see full application of stealth materials and detail component design until we see later prototypes. This is a risk minimisation strategy.

The aerodynamic design of the T-50 is innovative, and intended clearly to achieve 'extreme agility' throughout the envelope. The fully moving tails, movable inlet strakes, 3D thrust vectoring, and leading and trailing edge surfaces extend considerably on the superlative aerodynamics of the Flanker. The T-50 is clearly intended to outfly the F-22 in close combat and supersonic combat.

Most of the T-50's weapons will be carried in a long weapon bay in the floor of the fuselage tunnel. Two 'scab' fairings were evidently added late in the design to carry WVR missiles, likely the RVV-MD in early aircraft. Intended early weapons include the RVV-MD, an enhanced R-73/74 Archer, the RVV-SD, an enhanced R-77M Adder, and the large 200 nautical mile R-172 missile, intended to kill AEW&C aircraft and tankers from standoff ranges. A new internally carried ASM is in development, as is a yet to be displayed small diameter bomb analogue.

The sensor suite is to include the large Tikhomirov-NIIP active phased array or AESA radar, a new Infrared Search/Track system, and an advanced radio-frequency surveillance system, a suite similar to that initially planned for the F-22A Raptor.

While uncertainties will continue with respect to the stealth performance of the aft fuselage, it is abundantly clear that the T-50 PAK-FA will not match the stealth performance of the F-22A Raptor, but will be more agile and manoeuvrable, especially in close combat, and will have better range and persistence by virtue of greater fuel fraction.

The T-50 PAK-AF will outperform the F-35 Joint Strike Fighter in all cardinal parameters, and will in a mature design produce similar stealth performance.

Evolved legacy fighters like the F-15SE, F/A-18E/F and Eurocanards are wholly outclassed by the T-50 and have little hope of surviving in combat with this design.

Current planning indicates a build of 200 aircraft for Russia, a similar number for India, and 600 or more aircraft for other export clientele.

The T-50 PAK-FA is a significant technological advance by Russia, and breaks the three decade long monopoly on stealth design held by the United States. In strategic terms, it completely nullifies established United States planning for its fighter fleet recapitalisation, as only the F-22A Raptor is viable in airspace defended by the T-50 PAK-FA.

Su-35S Flanker E+

The Su-35S is the last planned major variant of the Flanker series, the intent being to supply it to clientele who cannot afford or otherwise qualify for the PAK-FA - although historically few nations have been denied the top tier Russian product when the price was right.

The history of the S-35S is that it was initially defined as a 'deep upgrade' to the existing Su-27/Su-35 Flanker E, bought in modest numbers by the Russian Air Force during the 1990s, but never exported. This design, marketed as the Su-35BM or 'Bol'shaya Modernizatsia', involved gutting the original Su-27M/Su-35 Flanker E airframes, and replacing the engines with 3D thrust vectoring supercruise capable -117S engines. Avionics and systems have been replaced with entirely new fully digital technology, but retaining most of the original airframe. As the Su-35BM program progressed, it was changed into the design and delivery of a new build airframe, with additional refinements to increase internal fuel capacity and reduce empty weight.

The resulting Su-35S prototypes first appeared around two years ago, and are intended to enter early production sometime in the next few months. Sukhoi have conducted an aggressive flight test program and it is expected that the planned IOC will be met. Initial orders for 48 aircraft for the Russian Air Force have been placed, and the aircraft has been widely marketed on the global stage, with target clientele including the Chinese PLA, as well as Middle Eastern and Latin American nations.

The Su-35S is a fully digital design, and the highest performing Flanker variant, with supercruise capability, albeit not as good as the supercruise optimised F-22A Raptor. The new Irbis E hybrid phased array radar has around twice the power-aperture performance rating of the Super Hornet's APG-79, with commensurate range advantages, but less performance than the APG-82 active phased array intended for block upgrades on some F-15 variants.

In terms of raw kinematic performance and agility, the Su-35S outclasses all Western fighters other than the F-22A Raptor. In terms of radar range performance, it falls slightly below the F-22A's APG-77 and the intended APG-82 F-15C/E installation. The combination of a long range radar and supercruise allows the aircraft to gain up to 30 percent more kinematic range out of its intended Beyond Visual Range missile armament, in comparison with conventional fighters like the F/A-18 series or the F-35, which must shoot "uphill" if attempting to engage the higher and faster flying Su-35S.

The Su-35S carries a comprehensive radiofrequency offensive/defensive suite, including Digital RF Memory wingtip RF jammers for the mid/upper bands, and an optional Low/Mid band jamming pod. Extensive application of radar absorbent materials was performed, especially to reduce engine inlet signatures in the upper bands.

The weapons mix offered on the aircraft includes the RVV-MD, the RVV-SD, and the 200 nautical mile R-172 missile. In addition to this formidable suite of air-air weapons, the full range of existing Russian air-surface munitions is to be cleared, including the supersonic Kh-41 Moskit/Sunburn, Kh-61 Yakhont/Stallion, and 3M54 Klub/Sizzler cruise missiles, and GNPP KAB series of electro-optical and satellite aided inertially guided bombs.

The aircraft has an aerial refuelling probe, and wet pylons for external carriage of fuel tanks, yielding F-111-like range performance.

The high performance of the Su-35S, its large missile payload, excellent persistence and long range sensor capability make the most lethal conventional fighter ever built.

Opposite page and above:
Sukhoi T-50 PAK-AF stealth fighter.

Su-27SKM Flanker B+

In parallel with the new Su-35S, Sukhoi and KnAAPO developed a major digital block upgrade for the widely deployed Su-27SK Flanker B, and are offering also new build airframes. The Flanker B export variant is operated in large numbers by China, and has been exported to Indonesia and a range of other nations. It is based upon the Soviet era 1980s Su-27S, which as delivered had an avionic capability similar to the early partly digital F-15A/B variants. The new digital weapon system adds a modern glass cockpit, incremental upgrades to radar, IRST and EWSP, but importantly provides a full precision strike capability with Precision Guided Munitions, absent in the original export Su-27SK, which was limited to visual or level dumb bomb deliveries. The Su-27SKM upgrade provides access to most of the extensive suite of Russian built PGMs. In addition, the retractable refuelling probe delivered on the Su-30MKK/MKI is retrofitted.

This upgrade allows existing users of the Su-27SK to convert these older aircraft to the dedicated strike role, replacing them with the better performing Su-30MKM Flanker H or Su-35S Flanker E in the air superiority role. While the Su-27SK/SKM does not offer the stellar performance of the Su-35S, it outperforms all Western fighters other than F-15 variants with higher thrust late build engines, and the F-22A Raptor.

Su-30MKM Flanker H

The Sukhoi/Irkut Su-30MKM is a derivative of the thrust vectoring dual seat multirole Su-30MKI initially developed by Sukhoi and Irkut for India, to occupy the same niche as the Boeing F-15E/S/K/SG. The Indian aircraft employed various items of Israeli supplied equipment, including the same Elta-8222 EWSP pod supplied for Australian F-111 aircraft. The Malaysian aircraft had these components replaced with Russian or French equipment, including the Thales Damocles thermal imaging targeting pod. Russia has since procured licence production rights for the pod, which can designate for arbitrary Russian or Western supplied laser guided weapons.

While Malaysia was the initial target for the Su-30MKM, the aircraft has since been offered for export to other clientele.

Su-34 Fullback

The Su-34 Fullback, developed by Sukhoi and now being built by NAPO in Novosibirsk, was initially prototyped at the end of the Cold War, and remained in development until a half decade ago when production for the Russian Air Force was authorised. The first two production aircraft were delivered by NAPO in December 2009, with low rate deliveries continuing.

The Fullback is a derivative of the Flanker, but it is a much larger and heavier aircraft, in the range-payload and weight class of the F-111. It was developed to replace the Su-24 Fencer, the intent being to provide capability equal or better to the F-111, which outperformed the Fencer.

The Su-34 is primarily a strike aircraft, but has a respectable air-to-air capability, using the multimode Leninetz B005 phased array radar, which is in basic technology and capability comparable to the APQ-164 in the Boeing B-1B Lancer. The radar can interleave, concurrently, waveforms for terrain following and targeting, as well as aerial target search. The aircraft has a side by side deal seat cockpit similar in concept to the F-111, but accessed via a ventral ladder. The crew are seated on a pair of individual ejection seats.

At least two variants of the basic airframe have been proposed, and in part demonstrated. These include a maritime variant with ASW sensors and weapons, and a Electronic Attack variant, modelled on the EF-111A Raven, but carrying external jammer pods like the EA-18G.

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Sukhoi/NAPO Su-34 Fullback.

Sukhoi/KnAAPO Su-27SKM Flanker B Plus".