Operationalising the *Gorshkov*: An Appraisal

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Abstract

The paper takes a critical look at various issues connected with India's acquisition of the Russian aircraft carrier, the Admiral Gorshkov. *It examines India's choice of fighter and various problems it is likely to face in making the carrier operational and fully effective for its task. It recommends the early acquisition of aerial refuelling and early warning systems by the Navy. The paper also argues for greater jointmanship among the services and an increase in specialist cross-postings in order to improve inter-service rapport and the pool of trained manpower.*

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Introduction

On January 20, 2004, India finally signed the deal to acquire the 44,900-ton Russian aircraft carrier, the *Admiral Gorshkov*, the replacement for the *Vikrant*. [1] The *Vikrant*, India's first aircraft carrier, had been commissioned in 1961.

Indian efforts to acquire its first carrier began in 1948, soon after independence, when an expansion plan mooted the concept of two fleets on either ocean flank, with a light carrier each. These were to be replaced later by two fleet carriers. Naval plans also called for the creation of 16 squadrons and two Fleet Replacement Units (FRU) for training — a total of 280 aircraft.[2] The Government was however, reluctant to accept the proposal due to the huge outlay involved. It eventually agreed to the acquisition of one light carrier in 1955, followed by that of another, if available, in 1957.[3] Plans for a second carrier were later put on hold due to fund constraints. A Fleet Air Arm was also approved in 1950. This called for the acquisition of a fighter and a strike squadron, with 16 aircraft each, for each carrier. However, pilot training had already begun in 1948, with the help of the Royal Navy.[4] The Indian Navy had to wait till 1986 to obtain its long sought after second carrier,

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with the acquisition of *INS Viraat*, formerly *HMS Hermes*. In this context, it is noteworthy that the Indian navy actually has more experience operating aircraft carriers than the Russian Navy.

The *Admiral Gorshkov*, formerly the *Baku*, was initially classified as an anti-submarine cruiser.[5] This classification was later changed to that of tactical aircraft-carrying cruiser.[6] Only four ships of the type were built, the lead ship, the *Kiev*, launched in 1972. The *Baku* was the fourth and last *Kiev* class carrier. It was retired by the Russian Navy in 1994, after budget cuts made operations unsustainable.

The *Gorshkov* was named after Admiral Sergei Gorshkov, the father of the Soviet Union's blue-water navy. Until he took over, the Soviet Navy had emphasised submarine construction and ballistic missile deterrence. However, Soviet views on naval power were profoundly affected by the Soviet Union's inability to challenge the US Navy's blockade of Cuba during the 1962 Cuban missile crisis.[7] Soviet analysis attributed the humiliation to the weakness of their surface navy.[8] While nuclear submarines might have deterrent capability, they could not run blockades. *Admiral Gorshkov* felt that the Soviet Navy needed to project power on the world's oceans, to challenge US domination. During his thirty-year stint as Commander-in-Chief of the Soviet Navy, he changed Soviet naval policy to favour the construction of large, powerful guided missile cruisers like the *Sverdlov* class and culminating in the *Kirov* class cruisers, instead of the corvettes and destroyers that were the staple earlier. The Soviet Navy also started a programme for the construction of aircraft carriers. The first ships of this type, the *Moskva* class helicopter cruisers, launched in 1965, operated only helicopters. The *Kiev* class which followed were the first Soviet ships to operate fighters. This kind of incremental progress was typical of the Soviet development process. To operate from these ships, the Yakovlev aircraft design bureau developed the Yak-36 and Yak-38 fighters. While initially only VTOL (Vertical Takeoff and Landing) capable, a STOVL (Short Takeoff and Vertical Landing) capability was later built up. Unlike the British Sea-Harrier however, these aircraft had three engines, two for lift and one for forward flight. This made them considerably less flexible and versatile than the Harrier.

Operationalising the *Gorshkov*

Before it can become operational, the *Gorshkov* will have to be refurbished. It has been lying alongside in Severodvinsk in the White Sea,

near Arkhangelsk, since 1996. The various contracts concluded will cover the fitment of a ramp or ski-jump angled at 14.3 degrees, various radar, avionics and landing systems and modifications to the ship to enable it to operate the MiG-29K, which has been selected by the Indian Navy.[9]

Indications are that the forward deck, which now houses launchers for the SS-N-12 *Bazalt* cruise missiles (SSMs) and the SA-N-9 *Gauntlet* SAMs will be cleared to fit the ski-jump on the forward flight deck.[9] This would create more space on deck to make it a true flat-top. Blast deflectors and restraints to enable aircraft to run up to maximum power before take-off, will also need to be be fitted. The angled deck will also incorporate arrester cables to enable the MiG-29K to land.[10] According to one source, the forward deck runway could be 200m long with the landing runway being 198m long.[11]

Redesigning the Island

The *Kiev* class was only the second generation of Soviet carriers. The Soviets were thus on a learning curve. This could account for the rather large island on the *Gorshkov*. This has a very large footprint, by western standards, and greatly reduces the area available on deck for aircraft operations.[12] Since the *Gorshkov* was originally designed to operate only the Yak-36/38 and helicopters, this did not matter very much then. However, with the decision to operate rather larger fighters, deck space will be at a premium. Operations would benefit if the island could be redesigned to occupy a smaller footprint on the flight deck, with greater overhangs above, as in the *Nimitz* or *Charles de Gaulle*.[13] There would then be enough room above for the bridge and flying control, while the deck could be de-cluttered. This would also enable the incorporation of a suitably angled forward flight deck, with the SAMs and SSMs removed.

Indeed, the new US carrier class, the CVN 21, due to enter service in the year 2014, is being planned with the island shifted aft and outboard and with a very small footprint, in order to increase deck operating and parking area.[14] Further, all operations not considered absolutely essential will be moved out of the island and below deck, to make it smaller. This includes the flag bridge, normally below the ship's bridge on the *Nimitz* class.[14] Reducing the island's size will also have the added benefit of reducing radar cross-section, with suitable redesign, for whatever that is worth.

A Catapult for the *Gorshkov*

According to *Frontline* magazine, the installation of a powder-type catapult on the *Gorshkov* is being considered.[15] The *Nimitz* class carriers of the US Navy use steam catapults, instead of hydraulic or explosive powered catapults. These are reportedly capable of accelerating a 20 tonne aircraft from 0 to 266 kmph in two seconds.[16] The new CVN 21 class will use electro-magnetic aircraft launching systems (EMALS). [17]

The fitment of a catapult on the angled deck would enable two aircraft to take-off simultaneously, one using the catapult and the other, the ski-jump. Since an extensive refit will in any case be undertaken, the feasibility of the fitment of a catapult needs to be considered, in view of its operational utility. Russian efforts to fit a catapult on the *Admiral Kuznetsov* were apparently not successful. However, we need to tap any available expertise, whether Russian, French or American.

Once work is complete, the *Gorshkov* will have a maximum speed of 30 knots and an operational range of about 13,800 nautical miles (about 26,000 km) at 18 knots. It will carry a normal complement of 24 MiG-29K and six helicopters. The Ka-28 and Ka-31 helicopters have also been contracted. The Ka-28 helicopters will have an anti-submarine warfare (ASW) role. The Ka-31 is an early warning helicopter and will be used mainly to detect aerial threats. Eleven MiG-29s will remain on deck. The hangar can reportedly house either 13 fighters and six helicopters or ten fighters and 13 helicopters. The ship will thus be able to operate a maximum of 34 aircraft. [18]

The *Gorshkov* will take about five years to operationalise, at the very least. With the *Viraat* expected to soldier on till 2010, there will therefore be a period when both the *Gorshkov* and the *Viraat* are in operation together. However, each will be able to operate only its own type of aircraft – MiG-29s on the *Gorshkov* and Sea-Harriers on the *Viraat*. This is because the Sea-Harriers would not be able to takeoff from the *Gorshkov's* proposed ski-jump, which would be too sharply angled. The aircraft's undercarriage would not be able to take the strain of rotation. The MiG-29s would have difficulty taking off from the *Viraat's* short deck without a catapult. In any case, the *Viraat* lacks the arresting gear necessary for the MiG-29K to land safely.

A compromise, which might enable both types to be operated from the *Gorshkov*, would be to reduce the ski-jump angle from the planned 14.3 degrees to a more moderate 10-12 degrees. This would allow the Sea-Harriers

to operate from the *Gorshkov* and also provide the MiG-29s sufficient ballistic boost for take-off. However, this would only be justifiable if the Sea-Harriers were likely to be around for longer than planned.

The *Viraat* will retire in 2010. The Sea-Harriers too, are due to go out of service in 2010, unless they are upgraded to Sea-Harrier II standard. A mid-life update was reportedly planned in 1999, but cancelled in view of the impending *Gorshkov*/MiG-29 deal. It is now reported that an upgrade, probably featuring the Israeli ELTA EL/M 2032 radar and air-to-air missiles, may be carried out by HAL. However, this has not been finalised.

Operating Two Different Fighters

Operating two fighters of different origin from a carrier is difficult. If we consider only the maintenance angle, the entire range of maintenance tools, testers and spares would have to be available on the ship. With hardly any commonality between the two types, this would mean having full sets of such equipment for each type, along with manpower trained on each type. Further, differences in fuel, oil and lubrication specifications, which could require different storage arrangements, would also need to be considered. Imagine a carrier deployment with, say fifteen MiG-29Ks and fifteen Sea-Harriers to the South China Sea for a period of two months, with each aircraft averaging three sorties a day. Assume an average consumption of 4,000 and 3,000 litres per sortie each for the MiG-29K and Sea-Harrier respectively. The *Gorshkov* carries 1,200 tonnes of aviation fuel (1.5 million litres).[19] However, another report indicates that the ship will carry 1,500 tonnes (1.9 million litres). It will also carry 260 tonnes of aircraft ammunition, bombs and missiles etc., which also have to be provisioned for operations.[20] Merely imagining the housekeeping requirements makes the mind boggle. Extended deployments presuppose sufficient tanker and replenishment at sea capabilities. This capability too needs to be built up. As a point of interest, the *Nimitz* class carriers carry as much as 11.3 million litres on board,[21] sufficient for 12 days operations.[22]

Choice of Carrier Fighter : The Su-30/33 or The MiG-29K

The choice of fighter aircraft to operate on the carrier is an issue which may be debated. The MiG-29K has been selected as the carrier aircraft. However, despite its undoubted capabilities, it will add another fighter type to the many that India already operates, and all that means in terms of

maintenance and spares problems. The Russian carrier, the *Admiral Kuznetsov*, operates the Su-33, a naval variant of the Su-30, which the IAF already operates. Navalising an aircraft mainly involves modifying the undercarriage for the stresses of carrier landing, the fitment of a tail-hook, the strengthening of the hook attachment point and the incorporation of wing and stabiliser folding mechanisms to cater for cramped operating and storage areas. This has already been done for the Su-33. [23] In fact, the aircraft has already had its fins clipped to reduce it's height from 6.35m to 5.72m in order to enable it to be housed in the Kuznetsov's hangar. [23] The other considerations are anti-corrosion measures for the airframe and the engines. However, these do not involve major re-design but merely need certain maintenance procedures and practices to be followed.

Selection of the Su-30 would have ensured a certain commonality between the Air Force and the Indian Navy and also facilitated cross training between the two services. greatly furthering the concept of jointmanship. It would also have resulted in greater work for HAL, which is to manufacture the Su-30 in India.

The Su-30 is definitely the more capable aircraft (Table-1). It has greater range and endurance. This would give it the ability to range over greater expanses of ocean and enable the carrier to exercise greater sea control over vast swathes. The Su-30's superior radar (even more so in the MKIII version) would enable it to detect and attack targets in collaboration with the maritime reconnaissance aircraft. It has a greater payload. The Su-30 and the MiG-29K are about equal at the moment, in terms of manoeuvrability. However, the Su-30MKIII with its canards and thrust vectoring nozzles would be far more manoeuvrable.

Table-1: Comparison of the MiG-29K, Su-30 and Su-33

Specifications	MiG-29K	Su-30	Su-33
Length	17.32m/ 14.13m*	21.9m	21.185m?
Wing Span	11.36m/ 5.80m**	14.7m	14.7 m/ 7.4 m**
Height	4.73m	6.4m	5.72 m
Empty Weight	10,500 kg	17,700 kg	-

Contd...

Table-1: Comparison of the MiG-29K, Su-30 and Su-33 (*...Contd*)

Specifications	MiG-29K	Su-30	Su-33
Normal T/O Weight	16,800 kg	24,900 kg	25,000 kg
Max All Up Weight (AUW)	22,000 kg	3,4500 kg	30,000 kg (carrier)
Max Payload	-	-	33,000 kg
Hard points	4,500 kg	8,000 kg	7,000 kg
Ferry Range	9 km	-	12 km

*- with radome folded ** - with wings folded – including folded noseprobe
% - 3 drop tanks † - single refuel;ling

Source: (Data from Jane's All the World's aircraft 2001-2002) and "MiG-29K" , Brassey's World Aircraft and Systems Directory 1999/2000 and http://www.globalsecurity.org/military/world/russia/mig-29k.htm)

The Brahmos Anti-Ship Missile

India and Russia have now jointly developed the Brahmos anti-ship missile, which is reportedly one of the most advanced in the world. The original Russian "Moskit" 3M82 missile (airborne version of 3M80 naval SSM, NATO SS-N-22 Sunburn), on which the Brahmos is based, was also tri-sonic, a design characteristic implemented essentially to defeat the Aegis class destroyers of the US Navy. These destroyers use a sophisticated, computerised threat evaluation and destruction system and are used for fleet defence. Soviet analysis deduced that these ships could be defeated by a very fast missile, which would hit the ship, before it had completed its "detect-launch-destroy" cycle. [24] Hence the "Moskit". Similarly, the Brahmos missile can hit ships up to 290 km away. As it travels at close to three times the speed of sound, any potential target would find it difficult to evade. Detection and counter-measures would also be difficult to implement, in view of the short reaction time afforded by its great speed. However, the standard version weighs about three tonnes and is over eight metres long. An airborne version is being developed. It is doubtful whether the weight can be reduced without affecting its capability. This would probably preclude its carriage by any fighter other than the Su-30. Even the Su-30 can only carry one on the underbelly station. The aircraft's wings are planned to be strengthened to carry two more missiles. This would give the Su-30 tremendous anti-ship capability and would have made it a welcome addition to the *Admiral*

Gorshkov. The MiG-29K will probably be unable to carry the Brahmos, due to its load carrying limitations, without extensive modification, which may not be cost-beneficial.

Why We Opted for the MiG-29K: Some Possible Reasons

One possible reason we have opted for the MiG-29K instead of the Su-30/33 could be its smaller size. This would allow more aircraft to be accommodated on the *Gorshkov*'s deck and in its hangar. A second could also be doubts about deck strength requirements for operating the Su-33, which has a maximum carrier take-off All Up Weight (AUW) of 30 tonnes, compared to the MiG-29K's max AUW of 22 tonnes.[25] A third possibility could be the elevator weight limits on the *Gorshkov*. However, it is understood that one lift has a 20-ton capacity and that the other is being upgraded to 30-ton capacity.[26] This latter would have been sufficient for operating the Su-30. However, the main consideration could possibly have been hangar height limitations on the *Gorshkov*, which would leave little, if any, clearance for the Su-33. According to one report, the hangar on the *Gorshkov* has dimensions 130m x 23m x 5.7m,[26] compared to the Kuznetsov's 153m x 26m x 7.2m.[27] The Su-33's fins were reportedly shortened to enable it to fit into the Kuznetsov's hangar deck.[28] While some of these problems could possibly have been addressed in the refit, that of hangar height probably was the decisive factor against the Su-30/33.

Another reason for our selection of the MiG-29K could possibly be due to the *Gorshkov* being offered as part of a package deal with the MiG-29K. Of late, orders for fighters, both from the Russian Air Force and abroad, have been cornered by the Sukhoi bureau. Given the shrinking defence budget, Russia has found it difficult to support both firms by splitting Air Force fighter requirements between the MiG and Sukhoi bureaus. Therefore, governmental assistance to help the MiG bureau obtain export contracts is in order. This would serve to keep this famous design bureau from disappearing altogether and help the country retain the design expertise it has built up over the years.

The MiG-29K

While the Indian Air Force acquired the MiG-29 in 1986, it was first displayed in the West during the Farnborough Air Show in 1988. It's superb manoeuvrability made it an instant hit. Since then many versions have been

developed. The MiG-29, selected for the *Gorshkov* is a development of the MiG-29SMT. At the time the MiG-29SMT was first displayed, Rostislav Belyakov, then Chief Designer of the Mikoyan Bureau, was quoted as saying that the aircraft was actually entirely a new aircraft. The MiG-29 label had been retained mainly for its 'brand recognition' value. The MiG-29K incorporates improved avionics, radar, engines and fly-by-wire controls. While the superb manoeuvrability of the MiG-29 was achieved through aerodynamic design and a purely hydro-mechanical control system, the MiG-29K will in fact further improve that performance with its fly-by-wire controls. Internal fuel capacity has been increased and an in-flight refuelling capability has been added. The aircraft will also be able to carry drop fuel tanks. All this should go a long way to improve its flight endurance, one of the main complaints against the original MiG-29 being its inadequate fuel capacity. It will also have improved pulse-Doppler radar and opto-electronic sensors, besides an active data-link. The aircraft will carry the latest air-to-air missiles (AAMs), like the RVV-AE active AAM, the R-73 short range AAM and also a variety of air-to-surface armament. The MiG-29K's airframe has been lightened and clipped, and the wing-fold pivots moved inwards towards the fuselage. All this, together with the folding tail unit, will ensure that it occupies less space on deck. The aircraft's internal fuel has also been increased from 3,340 kg in the series production MiG-29 to 4,560 kg in the MiG-29K. A buddy refuelling capability has also been built in with the UPAZ refuelling pack. This version will carry 7,820 kg.[29] Eleven MiG-29s will be able to park on deck. The rest will be housed in the hangar below decks.

Landing Conventionally on the *Gorshkov*

Landing on a carrier is always a tricky affair, whether vertically on a Harrier, or conventionally, on an F-14 or a MiG-29K. Both are different skill-sets. Since the Sea-Hawk was retired, the Indian Navy's fighter pilots have landed only vertically, on the Sea-Harrier. The art of making a conventional approach and engaging an arrester cable, never an easy one, has by now been lost. This skill will have to be re-acquired. Where will the training be done?

The Russian carrier, the *Admiral Kuznetsov* operates the Su-33 and in any case, puts to sea only rarely. A recent article in Pravda dated in early February this year, quotes the Commander-in-Chief of the Russian Navy, Admiral Vladimir Kuroyedov, as saying that Russia has no need of an aircraft carrier.[30] According to Kuroyedov, Russia has no blue water ambitions for

the foreseeable future. In fact, it plans to acquire smaller vessels like destroyers and corvettes, suitable for a coastal defence role, rather than the large cruisers of the Kirov class, favoured by *Admiral Gorshkov*.

The same article quotes a Russian defence expert as saying that the *Admiral Kuznetsov*, should be scrapped since it is uneconomical to operate. In fact, according to him, Russia has only twelve naval pilots left, and this number does not justify the maintenance of an aircraft carrier.[30] The Russian Navy is not therefore likely to be in any position to train Indian naval pilots in carrier operations. In fact, according to Russian analyst, Mikhail Tsypkhin, Russian naval fighter crews fly an average of only seven hours a year.[31] The question of who is to train whom is therefore moot. The US Navy could be approached for training, but they operate different aircraft and use different systems. It is obvious therefore, that any training on the *Gorshkov* will have to be carried out at home.

On landing, the MiG-29K will be brought to a halt by having its tail-hook grabbed by cables connected to an energy absorption system. In order to ensure that the arrester cable is engaged by the tail-hook, conventional aircraft like the US Navy's F-14 Tomahawk and F-18 Hornet, and the MiG-29K, are generally banged down on deck, on landing. For this reason, carrier landings are often described in pilot jargon as 'arrivals' or 'smack-downs'.

Pilots will be aided by a landing system, which will tell them whether they are high or low on approach. This could be a laser or microwave system, unlike with the *Viraat*, which uses a Mirror Landing System. The Commander Air, who would normally control all flying activity on the carrier, would be aided by lights on the nose undercarriage of the MiG-29, which would change colour depending on the aircraft's angle of attack. On touch-down, the MiG-29's tail-hook, lowered along with the undercarriage for landing, would engage an arrester cable stretched across deck. About three to four such cables would be available for redundancy. If an aircraft misses one, it will usually engage another. In the event that the aircraft fails to catch any of these, we have what the US Navy calls a 'bolter' — an aircraft that has to go around again and make another attempt at landing. This raises another issue.

The Requirement of Aerial Refuelling

In carrier operations, aircraft sometimes return with low fuel states. In case of out of range of airfields ashore, the aircraft have no option but to land

on the carrier. However, the lack of fuel itself complicates the recovery. After one or two failed attempts to catch the cable, the pilot's awareness of his rapidly reducing fuel state often induces nervousness, further aggravating the situation, leading to a loss of motor skills, and in extreme cases, of the aircraft. This situation is by no means uncommon. In the US Navy, this is usually handled by launching an aerial refuelling aircraft to transfer fuel to a serial 'bolter'. It has been observed that this is often followed by a perfect landing on the next attempt, the pilot recovering his nerve and flying skills as his aircraft imbibes the fuel it needs to stay airborne. Therefore, for successful long-range and long-duration operations, it is imperative that a ship-board refuelling aircraft be available. This could be a buddy-refueller — a MiG-29K itself modified to carry a refuelling pod to supply fuel — or a specialist refuelling aircraft, which could also carry out anti-submarine (ASW) or Electronic Warfare (EW) duties in addition.

The first approach would seem preferable. A number of MiG-29Ks modified to carry the refuelling pod, would confer a degree of flexibility in operations. Performance similar to that of the fighter could also be advantageous in certain critical refuelling situations. The US Navy earlier used the Grumman EA-6B Electronic Warfare aircraft, some of which were modified to serve as buddy-refuellers. An interesting description of combat operations from an aircraft carrier can be obtained from Stephen Coontz's book, *The Flight of the Intruder*. Even today, buddy refuelling systems are extensively used by the US Navy, which has modified S3A Viking ASW aircraft and F-18E/F fighters for the role, using Sargent Fletcher's buddy refuelling systems. The F3 version of the Rafale, France's latest naval and air force fighter, will also have buddy-buddy refuelling capability.

In any case, the need for aerial refuelling capability is inescapable.

Airborne Early Warning

An aircraft carrier is a prime target for any attacker. It is a national asset carrying tens of aircraft and a repository of national prestige. Any successful attack on a carrier could conceivably alter the course of any conflict. The Japanese attack on Pearl Harbour on December 7, 1941, was despite its success, ultimately a failure, because it failed to damage any of the American carriers, which fortunately for the US, happened to be at sea on that fateful day. Had they been sunk, as were the battleships in harbour that day, the course of the war might have been different. Carriers are normally protected

by a screen of ships, some specially developed for that purpose. This has led many to question the worth of a weapon, which needs to be so heavily defended. Be that as it may, an aircraft carrier needs to be defended, from surface, sub-surface and aerial attacks.

Defence against aerial and surface attacks would require the availability of an Airborne Early Warning (AEW) aircraft. On the *Gorshkov*, this will be provided by the Ka-31 helicopter. The radar can detect fighter-sized aircraft from a range of 110-115 km and surface ships at a horizon of 200 km from an altitude of three km. It is claimed that up to 200 targets can be detected and twenty airborne or surface threats simultaneously tracked, with a detection range for aerial targets up to 80 nautical miles (150 km) and for surface targets up to 135 nautical miles (250 km).[32] However, helicopters have limited range and endurance and cannot match conventional aircraft in both these aspects.

The US Navy uses the carrier-launched E2C Grumman Hawkeye. At one time in the eighties, there were reports that Pakistan had been offered these aircraft. With the IAF going in for the Israeli Phalcon system mounted on an Il-76 airframe, some thought needs to be given to a naval variant. This cannot obviously use the II-76 airframe, but will need to be mounted on a smaller aircraft, one capable of being launched from the carrier. However, there is no reason why work on this cannot proceed concurrently with the Air Force requirement. A smaller version of the Phalcon radar, mounted on a small turbo-prop, would suit naval requirements quite nicely.

It is therefore clear that purposeful utilisation of the *Gorshkov* will require the acquisition of air-to-air refuelling and early warning capabilities. The acqui-sition of these capabilities would be a significant boost to national prepared-ness, one that the IAF might find itself thankful for in the future.

Operating a small tanker or AEW aircraft (transport aircraft) would be difficult without a catapult to assist launch. As mentioned earlier, this would require a study to determine the feasibility of catapult fitment. If judged feasible, this would greatly enhance operational capability.

Greater Navy-Air Force Cooperation

The IAF is today the sole operator of MiG-29s and has built up great experience in both operations and maintenance. This could be useful to the Navy as it decides on the equipment fit that it desires. The IAF's MiG-29s

are also long overdue for an upgrade, with improved avionics, radar and engine. Logically, this would dovetail quite well with the Navy's plans to acquire the MiG-29K.

With the acquisition of the MiG-29K, the IAF and the Navy will for the first time be operating a common fighter. Since the Navy's fighter fleet is quite small, it would be logical to have a number of IAF pilots also trained in carrier operations. This would both serve to improve inter-service relations and also provide a pool of trained pilots, who could be used for special operations involving the carrier, if necessary. Cooperation between the services needs to improve for this to happen. It is a sad but illuminating statistic on the relations between the services, that in the forty odd years that the Indian Navy has operated aircraft carriers, the number of IAF fighter pilots trained to carry out deck operations can be counted on the fingers of one hand. This needs to change.

Utilising the Su-30 and MiG-21 Upgrade Experience: System Integration on the MiG-29K

The MiG-29K will also need to be modified to suit Indian requirements and with avionics of our choice. In this context it is worth recalling that we already have two ongoing projects with the Russians, on the MiG-21 upgrade and the Su-30. The Su-30 programme envisages a three-stage modernisation, at the end of which the aircraft will have acquired a very comprehensive set of capabilities that will include major improvements and substantial changes to the original aircraft. The Su-30 MKIII (final version) will have thrust vectoring nozzles and canards (for super-manoeuvrability), a phased array radar, and so on. Since these require extensive work, it was proposed that the work be done in stages. The avionics selected for the Su-30 include Israeli, American, French, British and also indigenously developed equipment. In fact the mission computer in the Su-30MK versions was developed by the DRDO's Aeronautical Development Establishment and is said to be 'state of the art'. The MiG-21 upgrade too uses an array of avionics from different manufacturers, both Indian and foreign. Both aircraft incorporate the MIL 1553B databus to handle data exchange. The integration work has been carried out by Indian engineers, in collaboration with the aircraft and equipment manufacturers. A wealth of expertise has therefore been built up in systems integration. This experience may be utilised usefully in developing the MiG-29K. It is necessary that the lessons learnt during the course of the other two

projects be used in the MiG-29K project, instead of starting all over again with a tabula rasa and repeating the same mistakes. Developing the MiG-29K by drawing upon the experience of the Su-30 and MiG-21 upgrade programmes will require drawing upon the IAF's experience. This will necessitate looking at all these programmes and requirements as part of an integrated whole.

The Development of the Ski-Jump

We have taken close to a decade to decide on our purchase of the *Admiral Gorshkov*. The AJT decision has taken us twenty years. In this context, it is illuminating to learn how the ski-jump was conceptualised and implemented. A conventional aircraft taking off from a carrier, leaves the deck without actually having reached flight-sustaining speed. On a conventional flat top carrier, it actually sinks slightly soon after take-off, coming down to say thirty or twenty feet above the water, before it has picked up enough speed to climb. This is the most critical phase of flight. Any engine failure at this stage could be fatal. The ski-jump helps by giving a ballistic boost to the aircraft, effectively kicking it higher into the air. The aircraft thus continues to climb even though it has not yet reached flying speed. Taking off on a Harrier from the carrier, one can actually see the rate of climb reduce soon after take-off, before it starts showing an increase as the aircraft accelerates and achieves flight-sustaining speed. The ski-jump was the product of a doctoral thesis submitted by Lt Cdr Frank Taylor of the Royal Navy, in 1976. Impressed by the concept, the Royal Navy immediately implemented it. *HMS Hermes* was fitted with a ski-jump during refit in 1980, in time for the 1982 Falklands war. A ski-jump enables an aircraft to get airborne off a much shorter run. It also enables an aircraft to get airborne carrying a much heavier weapon load. Incidentally, fitting the ski-jump actually makes ship handling more difficult and so is not an unmixed blessing. *HMS Hermes* is today *INS Viraat*.

Interestingly, the US has not used the ski-jump thus far, since their carriers are large and provide a deck long enough for their fighters to take off comfortably, even if loaded. In any case, US carriers use steam catapults to enable the fighters to build up sufficient speed for take-off. And further, US Navy fighters like the F-18 enjoy high thrust to weight ratios (greater than or close to unity) and hence are capable of extremely high acceleration and rates of climb. This obviates to some extent the necessity for the ski-jump.

Conclusion

Acquiring the *Admiral Gorshkov* will be the easy part. Operationalising it will be much trickier. Decisions on the ship's configuration itself will need a lot of hard thinking, if it is to serve us well at least for the next two decades. Commonality of systems, between existing aircraft in inventory and the new acquisitions, therefore needs to be given high priority. Priority needs to be given to the early acquisition of aerial refuelling capability either through buddy-refuelling or through the acquisition of a tanker. While the Ka-31 does provide some early warning capability, this is not likely to match that provided by a fixed wing aircraft. This too needs consideration. Inter-service cooperation also needs to improve so that each service can benefit from the experience of the others. Cross-postings of specialists would help the services build up greater rapport than they enjoy presently. A beginning could be made by having more Air Force and naval pilots train together in operations aboard the carrier and ashore.

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