

Saab in Super Mode At the Crossroads Depleting Air Assets Life beyond LCA IOC Powering the Future Helicopter Modernisation

Dassault

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Depieting Air Assets

New Generation Gripen (photo courtesy Saab)

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Aerospace-& Defence Review

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Neighbourly assistance

Delhi's decision to finance Russian arms supplies to Kabul is a significant new element in India's efforts to cope with the consequences of the impending American military withdrawal from Afghanistan by the end of this year. After a decade of strong US military presence in Afghanistan, Kabul will soon be on its own in fending off the growing insurgent threat from Taliban. The Afghan armed forces have already taken the lead in securing the country and their performance has been impressive. But questions remain on whether they will be able sustain themselves for long, amid the declining Western support and Pakistan's continuing sanctuary and assistance to the Taliban and other forces seeking to destabilise Afghanistan.

It is no surprise, then, that Kabul is mobilising all the support it can from its friends in the region, including India. Under the strategic partnership agreement signed in 2011, Delhi had promised to supply arms and provide military assistance to Kabul. As Afghanistan sought the translation of this commitment into reality, the UPA government was torn between keeping its word to Kabul and the potential risks of provoking Pakistan, which has long been nervous about India's military footprint in Afghanistan. Delhi's turn to Moscow for organising arms supplies to Kabul helps overcome two of India's significant limitations in Afghanistan the absence of exportable surpluses of heavy weapons that Kabul is seeking and the lack of easy physical access to Afghanistan. Selling arms to Kabul is a big and necessary step forward in India's military cooperation with Afghanistan, which until now had been focused on training its military and police officers.

The next government in New Delhi must build on the current military initiatives in Afghanistan. For one, it can be bolder than the UPA in agreeing to train Kabul's security forces on Afghan soil. It could also assist Kabul in building the much-needed Afghan air force. The successor to UPA2 should, however, be acutely conscious of two important realities—that Delhi is not in a position to replace the American military assistance to Afghanistan and that its pockets will never be deep enough to finance largescale arms imports by Kabul. Working closely with others in Afghanistan, then, becomes critical for the pursuit of Indian objectives. India must complement its strategic collaboration with Russia by deepening military cooperation with Afghanistan's neighbours—Iran to the west and Tajikistan, Uzbekistan and Turkmenistan in the north.

From The Indian Express

New Navy Chief

A fter much deliberation and dilly-dallying lasting almost two months (50 days to be precise), the government appointed Vice Chief of Naval Staff Vice Admiral Rabinder Kumar Dhowan as the next Chief of Naval Staff. Dhowan had been officiating as the Navy Chief ever since his predecessor, Admiral Devender Kumar Joshi, resigned on February 26 in the wake of an accident on board INS *Sindhuratna*, a Russian-made *Kilo*-Class submarine, in the Arabian Sea. Joshi's resignation, the first by a Service chief, on the ground of moral responsibility had been hailed as an act of honour in keeping with the finest traditions of the military. Admiral Dhowan will have the major task of improving the morale within the Navy and possibly taking a re-look at training and the quality of manpower while refurbishing the image of a service that has taken a beating following a spate of accidents that occurred in quick succession. The most serious was the sinking of INS *Sindhurakshak*, another *Kilo*-Class submarine in August last year while docked in Mumbai following an on board explosion, which is considered unprecedented in the world's peacetime naval history. The Navy is paramount to India's security, power projection and international diplomacy alike. Moreover, in the event of a nuclear war, the Indian Navy would be banked upon to launch counterstrikes from indigenously made nuclear-powered submarines that, however, are yet to be inducted.

But the morale and image of the Navy cannot possibly be the responsibility of the Navy Chief alone. The government, notably the Ministry of Defence (MoD), too has a major role to play. The key issues afflicting the Navy are still at play - antiquated submarines, ships and other equipment, delays in induction and shortfall in the officer cadre to name a few. Admiral Dhowan has a major task ahead and a lot will depend on his leadership, contribution and his relationship with the political executive and the civilian bureaucracy.

From The Tribune



From The Economic Times

Damning indictment

Throughout the ten years of UPA rule Congress president Sonia Gandhi heaped praise on Prime Minister Manmohan Singh for his vision, leadership qualities and personal integrity. The latter, in turn, sometimes went to an embarrassing extent to return the compliment. But in Delhi's incestuous circle of senior politicians, bureaucrats and media persons, hardly anyone doubted that this mutual back-scratching was an elaborate charade. What Sanjaya Baru — who served as media adviser to Manmohan Singh in the UPA-I regime — has done in his book 'The Accidental Prime Minister' is to say aloud what many others have been murmuring beneath their breath. Namely that the Congress president used her political secretary, Ahmed Patel, and her chosen loyalists in the Prime Minister's Office and Cabinet to call the shots in matters ranging from the appointment of

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individuals to positions of power and influence to interference in the formulation and implementation of government policies. If Sonia Gandhi emerges in Baru's memoirs as a suave if manipulative figure behind the scenes, Manmohan Singh comes out as a victim. One of the few occasions when he asserted himself was when he threatened to put in his papers if he wasn't allowed to get the Indo-US nuclear deal through. Otherwise, he suffered one setback after another with stoicism. Senior ministers bypassed his authority and colleagues in PMO were at each other's throats in official meetings. And for all the acclaim he received for his spotless character, he was unable to check the government's slide into a quagmire of sleaze. So here was a Congress president who exercised power without responsibility, took credit for such successes as UPA was able to achieve and by that token attributed — often furtively — its failures to the executive. The result? A near-complete subversion of the Cabinet system. This is no doubt a damning indictment of UPA. The timing of the book's publication, coming as it is during Lok Sabha polls, will certainly raise eyebrows. Some will even see in it an attempt to settle personal scores. The PMO's statement that the author has misused his privileged position and access to high office and peddled 'fiction' and 'coloured views' for commercial gain is only to be expected and must be seen in this context. But Baru hasn't breached any law. His faults, if any, can only be attributed to journalistic legerdemain.

From The Times of India

Air Pocket

Regulation works best when it is used to offset market failure. However, when a regulator hinders normal functioning of the market, it is time to ask if the regulators existence harms customers. Directorate General of Civil Aviation (DGCA), the aviation regulator, has decided Spice Jet's attempt to compete better by slashing ticket price falls into a category of malpractice. In a competitive market, it is not uncommon for relatively weaker players to use price as a tool to gain market share. Thats one way in which competition aids customers. When DGCA prevents this, it raises the question of whom the regulator is really trying to protect. Protection of customers is where DGCA does not have a good record. A few months ago, US Federal Aviation Administration lowered India's ranking on account of inadequate regulatory oversight. It was another way of saying India's aviation safety falls short of international standards. This is one area where air passengers depend on DGCA to do its job well. While it appears unable to do this, it is not wanting on frivolous interventions. Recently, it also pulled up Spice Jet as it felt a dance routine by its cabin crew as part of its Holi celebration violated safety norms.

DGCA's recent intervention on pricing is worrisome because of the signal it sends. Recently the *Federation of Indian Airlines*, the industry lobby group, wrote to the regulator expressing apprehension that entry of Air Asia would hurt their bottom line. Discounted fares is Air Asia's key strategy in markets it is present. With the regulator sending a message that it disapproves of aggressive pricing, it is legitimate to ask whose interest it seeks to serve. DGCA can become an effective regulator only if it clearly defines its objectives : safeguarding customers, not cartels.

Learning the lessons

When people criticise Britain's mission to Afghanistan as having been a costly failure they rarely mean the original decision to be part of the campaign in 2001 to topple the Taliban Government and to drive Al Qaeda out of its bases. If there was an alternative following the 9/11 attacks on New York and Washington then it was certainly not convincing at the time, and does not seem any more plausible with the benefit of over a decade of hindsight.

But the decision in 2006 to deploy British troops to the southern Afghan province of Helmand is another matter. This was a move designed to safe-guard a strategically important area from Taliban control, and was originally conceived of as mostly being a confidence and infrastructure building operation. That was what ministers believed and that was what they told the public. Within weeks, however, British troops — under-equipped for the purpose found themselves defending a number of small, remote bases from increasingly determined insurgent assault.

The rest is not just history, but rather important lessons to be learnt. While no one questions the bravery of the troops deployed and we do not dispute the positive intentions of those that sent them, it is obvious that many mistakes were made and that as a result people died. So the most positive outcome of the costly and bloody Helmand operations would result if we could learn for the future from those mistakes.

That is why it seems so counter-productive for the Ministry of Defence to prevent the public from reading a new book which might allow us all to do just that. Mike Martin was formerly a captain in the Territorial Army, spent two years in Helmand, learned Pashtun, became an expert in its recent history and has now written his second book about the area, *An Intimate War—An Oral History of the Helmand Conflict 1978-2012*, based on dozens of interviews with people who have lived and fought there. Mr Martin is known to argue that poor local intelligence meant that British troops and their commanders were exploited and manipulated by armed factions in Helmand, and that consequently matters were made worse not better by the British military presence.

Mr Martin's book, originally based on a PhD thesis commissioned by the Government, was due to have its launch party but at almost the last moment, the Ministry of Defence effectively blocked publication by saying that parts of the book, as yet unspecified, despite requests from Mr Martin and his publishers, breach the Official Secrets Act.

The possible damage caused by publication would have to be very substantial indeed to justify the suppression of a book like this. As Major General Andrew Kennett has put it, the British armed forces must be a "learning association" which faces its errors with the same courage with which its soldiers, sailors and aircrew face their enemies. And the British public, which sends its sons and daughters to face danger on its behalf, must be a learning people too.

Almost the worst thing that Ministry officials or ministers could do would be to put the alleviation of embarrassment before the learning of vital lessons. At the moment, in the absence of any comment or explanation, it looks as though this is what they have done, and we urge them to change their minds.

From The Times of India



On the eve of a new national government, Air Marshal Brijesh D Jayal (retd) writes that manifestos of political parties concerning national defence remain somewhat casual and confused.



The eagerly awaited election manifesto of the recently elected majority party is in the public domain and it is natural for students of national security to look at it in some depth given the change of government at the Centre. Viewed from the perspective of the national security community and more so the armed forces, the document was eagerly anticipated.

The chapter on security is titled "Secure Indians — Zero Tolerance on Terrorism, Extremism and Crime". Within it are proposals under the broad headings of Internal Security, External Security, Defence Production and Independent Strategic Nuclear Programme. The chapter's title and the definition of comprehensive national security within it would appear to indicate that not just the traditional national security components of power — namely, military, economic, cyber and energy — but even those related to terrorism, extremism and crime are proposed to be brought under the national security umbrella. Further, even social ones like food, water and health have been added for good measure.

In general terms 'national security' refers to the country's external national security interests and is hence broadly associated with defence, foreign affairs and intelligence. Internal security issues like law and order, terrorism and extremism, on the other hand, come under the home ministry. Whilst there are bound to be some overlapping areas, the message coming out now is that there would be a much broader national security architecture extending beyond just the two. The problem one sees with this definition is that management of traditional national security will then encompass diverse sections of the government, thus diluting the focus of higher defence management. This at a time when there already exist serious organisational and management challenges, which have defied solution precisely because of divergent interests and views.

The manifesto has attempted to pre-empt this reservation with the rider — that national security cannot be compartmentalised with multiple power centres and needs a clear road map to address it head on which, in turn, involves radical systemic changes. Since neither the prescriptive systemic changes nor the associated road map have been further articulated, it is difficult not to draw the conclusion that these are good intentions (but) yet to undergo the rigour of in-depth study and analysis. Since these are issues of wider complexity, for the present, the discussion is limited to the external security aspects and will touch on other aspects only peripherally.

The ills affecting our national security establishment and management are not only well known but have been the subject of many a recent expert study covering higher defence management, defence research, defence production and other allied subjects. Rather than draw on these for possible prescriptions and offer preferred policy options, the manifesto chooses the middle path, possibly because there continue to be sectional interests and divergent views at play. Here are some obvious examples. On the long deliberated and vital issues like the appointment of a combined defence services/permanent joint chief of staff, ensuring greater participation of the armed forces in the decision-making process and the integration of the services headquarters with the ministry of defence, whilst the need has been accepted, the political will has been wanting. It is disappointing to see that the manifesto is silent on any definitive prescriptions. More so, as many of these were thought processes that owe their birth to the post -Kargil conflict period when the last National Democratic Alliance government was in the saddle.

The manifesto talks about modernising the armed forces, fast tracking defence purchases and increasing research and development in defence with the goal of developing indigenous defence technologies. These are mantras that have been played over and over again and have never been in dispute. What has been missing is the will and the innovative solutions to meet these complex challenges.

Modernisation of the armed forces is an immediate operational imperative because of decades of neglect and ever worsening external security challenges. Enhancing defence R&D and promoting indigenisation are equally important, but can bear fruit only in the longer term after we have taken steps to overcome current weaknesses, such as, prioritising investment in selected areas of defence R&D, rationalisation of defence production by streamlining defence public sector units, taking on board the private sector which has been straining at the leash for nearly a decade and innovative technology sharing and partnership arrangements with international leaders in the field. Again, no prescriptions are forthcoming.

Whilst many of the above issues of greater indigenisation would need structural reforms and will mature in the longer term, the immediate modernisation needs of the armed forces need fulfilling. If these urgent modernisation wish lists of the armed forces, along with making good serious deficiencies in combat equipment, are taken together, one fact that will stare even the uninitiated in the face is that the bill is simply not affordable. The manifesto obliquely admits that "with the financial situation worsening, the issue of national security can acquire a horrifying dimension". What it fails to admit is that this horrifying dimension is already upon us, presumably because then it would need to offer some bitter though inevitable tonic. And that is not the stuff of sweetsmelling manifestos.

The proposal to revisit India's nuclear doctrine and revise and update it, to make it relevant to the challenges of current times, is unexceptionable for two primary reasons. The first is that the international security scenario is highly dynamic and no security doctrine worth its while can remain static and yet expect to remain relevant. The second is the changed scenario of Pakistan that has inducted tactical nuclear missiles alongside its existing 'first use' policy. Any Pakistani belief that tactical nuclear weapon use to neutralise a superior Indian conventional force will not, in international and even Indian eyes, amount to nuclear escalation, needs to be belied through urgent review and modification of the doctrine.

One hopes that the commitment to "maintain a credible minimum deterrent that is in tune with changing geo strategic realities" also includes a review of the need for further verification and testing of our thermo nuclear device, considering that serious differences exist in our scientific community on the complete success of our only test. In any such decision-making, it is also imperative that the military is involved, as it is they who are responsible for the final operational use should such an occasion arise.

One of the biggest challenges facing the national security edifice is actually the very poor state of civil-military relations bordering on lack of trust and even occasional hostility. That the armed forces continue to be pushed down the ladder in terms of their status compared to their civil service counterparts and that the veterans have been deprived of whatever little respect is due to them are prime reasons that the youth of India, of the calibre that the armed forces need, are not coming forward to join. One can only regret that the manifesto is silent on the issue of civilmilitary relations — issues on which will finally rest the entire edifice of democratic India's national security.

The recognition that the increasing shortage of commissioned officers in the armed forces needs to be addressed is a welcome development. Unless, however, the underlying causes of why the armed forces are not attractive any more are analysed and recognised, this will remain a pious intention. The armed forces are short of the right calibre of officers primarily because we have by our own shortsighted policies made this an unattractive option.

Let us pause and reflect. What significant respect or honour are we according to the right-minded youth whom we would want to spend months on the lonely Siachen heights, or in submarines and combat aircraft that have outlived their lives and yet be willing to give their life for flag and country? Again, there are no thoughts on how this fundamental weakness is proposed to be handled.

It is also surprising that the solution being offered to make good the shortage of officers is to "set up four dedicated defence universities". In military parlance defence universities are places of higher professional learning in matters of security strategy and resource management and are for senior military and civil officers who will then shoulder higher level national security policy, planning and management responsibilities. Only very few countries have one such university each. Our own National Defence University has been over a decade in making, and its foundation stone was laid only in 2013. Does one sense that the specialists formulating the manifesto were unaware of what a defence university signifies?

Finally the commitment to build a "war memorial to recognise and honour the gallantry of our soldiers" is welcome, but a firm pledge to do so on the Central Vista in New Delhi is sadly missing. It is a crying shame that the *babus* of the ministry of urban development and *assorted jholawala* interests have had a veto on this very natural location for the national war memorial.

In the wake of the recently concluded historic national elections, a perusal of party manifestos and promises of the political parties conveys the impression that 'national security' is an unwanted baby and the armed forces the orphaned child. Let us hope this changes.

Saab

IAF helicopters in support of national elections

Some 35 helicopters of the IAF, primarily Mi-17s but also Cheetahs and Chetaks, were employed by the country's Election Commission in support of conducting the world's largest democratic process. The nine-phase election was held over five weeks, from 7 April to 12 May 2014, during which the helicopters flew over 1200 sorties, airlifting close to 5000 poll officials and staff and 135 tonnes of material including Electronic Voting Machines. The 2014 Lok



Sabha election also saw the widespread use of chartered aircraft and helicopters by politicians.

With 814.5 million voters, the 2014 Lok Sabha elections were by far the largest in the world. Voting took place in 543 constituencies and cost the exchequer Rs 3426 crores. Apart from IAF helicopters, the elections also required deployment of 120,000 paramilitary and state police personnel to ensure peaceful voting across 800,000 polling booths. The 2014 elections were also significant for the armed forces, with a Supreme Court directive ordering that men and women in the armed forces could vote at the place of their posting.

Narendra Modi is Prime Minister

Following the BJP's overwhelming victory, India's new Prime Minister Narendra Modi is reportedly planning to visit the Indian Navy's new aircraft carrier, INS *Vikramaditya*, in a quick demonstration of his commitment to India's security. The erstwhile *Admiral Gorshkov* arrived in India earlier this year and is based at INS *Kadamba* near Karwar.



The BJP won 282 seats in the recently concluded national elections, and Mr Modi, is expected to accord high priority to modernisation of the armed forces as well as boosting indigenous defence production.

Admiral RK Dhowan is Chief of the Naval Staff

Following the dramatic resignation of Admiral DK Joshi on 26 Febraury 2014, claiming moral responsibility for a spate of accidents affecting the Navy's warships, the Indian Navy functioned without a chief for close to two months. Admiral RK Dhowan, who was previously Vice Chief and officiating Chief following Admiral Joshi's resignation, was appointed Chief of the Naval Staff on 17 April 2014. The succession order also saw the resignation of Vice Admiral Shekar Sinha, FOC-in-C, Western Naval Command, then the senior-most officer after Admiral Joshi.



India's new Prime Minister Narendra Modi being felicitated by President Pranab Mukherjee



Admiral RK Dhowan was commissioned in the Navy on 1 January 1975, is a Navigation and Direction specialist who has served with distinction in an array of Command, Staff and Instructional appointments through his exemplary career spanning 40 years. He is an alumnus of the National Defence Academy, Defence Services Staff College and Naval War College, Newport, Rhode Island, USA.

He has commanded frontline warships including the INS *Khukri*, INS *Ranjit*, INS *Delhi* and served as Chief Staff Officer (Operations) Headquarters Western Naval Command. He has commanded the Eastern Fleet as Flag Officer Commanding and served as Chief of Staff at Headquarters Eastern Naval Command, Visakhapatnam. He also has the distinction of commanding the National Defence Academy.

Previously, the Admiral was Assistant Chief of the Naval Staff (Policy and Plans), Deputy Chief of Naval Staff and Vice Chief of Naval Staff.

Command changes in the Navy

The resignation of Admiral DK Joshi and the subsequent elevation of Admiral RK Dhowan as CNS has caused major reshuffle among the ranks of the Navy. Vice Admiral Sinha's resignation has left the post of FOC-in-C Western Naval Command (WNC) vacant, and Eastern Naval Command chief Vice Admiral Anil Chopra is likely to be moved to WNC. Head of the Southern Naval Command Vice Admiral Satish Soni is expected to replace Vice Admiral Chopra at ENC while Strategic Forces Commander Vice Admiral SPS Cheema may move to the Kochi-based Southern Naval Command. Vice Admiral Sunil Lamba, commandant of the National Defence College, could be moved to Naval headquarters or a Command and is "in line to become Navy chief when Admiral Dhowan retires in 2016."



Vice Admiral SPS Cheema with Admiral RK Dhowan

Addressing naval personnel stationed in the capital on his first working day, Admiral RK Dhowan exhorted personnel to work together as a team to get the Navy "back on track." The Admiral said that "the Indian Navy is a professional force and remedial measures are being taken to ensure that frequent accidents do not occur." He explained that safety audits had been conducted and things were being put in place and that the Indian Navy continued to be

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considered "one of the most professional forces in the world." The Navy chief also said Naval HQ needed to work harder to support its men who were operating ships, submarines and aircraft and professional advice on files should be forthcoming.

Lt Gen Dalbir Singh to be next Army Chief

L t Gen Dalbir Singh has been appointed as the next Army Chief, to succeed General Bikram Singh, due to retire on 31 July. The Appointments Committee of the Cabinet, led by former Prime Minister Manmohan Singh, cleared the appointment on 13 May 2014.



File photo of Lt Gen Dalbir Singh as GOC-in-C Eastern Command with General Bikram Singh, the COAS.

Lt Gen Dalbir Singh is currently Vice Chief of the Indian Army, and is a third generation soldier. An alumnus of Sainik School, Chittorgarh and the National Defence Academy, Khadakwasla, he was commissioned into 4/5 Gorkha Rifles (Frontier Force) in June 1974. As Company Commander, his unit as part of 53 Infantry Brigade, were amongst the first Indian troops of the IPKF in Sri Lanka.

The General Officer commanded 8 Mountain Division in Kargil from October 2007 to December 2008 before taking over III Corps in Dimapur (Nagaland). He was later GOC-in-C Eastern Army Command from mid-June 2012, before assuming the post of Vice Chief of the Army Staff on 31 December 2013. Lt General Dalbir Singh is also Colonel of the 5th Gorkha Rifles (FF).



Air Marshal SBP Sinha takes over as DCAS

Air Marshal SBP Sinha has taken over as the Deputy Chief of Air Staff at Air Headquarters. He has previously held important staff appointments at Air Headquarters including Deputy Director of Operations (Electronics Warfare), Principal Director of Plans, CISR and Acquisitions and Assistant Chief of Air Staff (Plans).

An alumnus of the National

Defence Academy, he was commissioned in the fighter stream on 15 June 1980, has over 3700 hours of flying experience on flying the Hunter, MiG-21, Mirage 2000 and Su-30MKI. A graduate of the Defence Services Staff College (DSSC), Wellington, he is a Cat 'A' Flying instructor, Instrument Rating Instructor and Examiner and has undergone operational courses



in France and the USA. He has commanded a MiG-21 squadron, was Commandant of Electronic Warfare Range, Air Officer Commanding of a Su-30MKI base and team leader of the AWACS Project Team in Israel.

He is Commodore Commandant of No.7 Squadron 'Battle Axes', presently operating the Mirage 2000.

Air Marshal SRK Nair is SASO Training Command

Air Marshal SRK Nair has taken over as Senior Air Staff Officer, Headquarters Training Command in Bangalore. He was commissioned in the transport aircraft stream of the Indian Air

Force in June 1980, flying the Otter, Avro 748, An-32, Dornier 228 and Il-76 and has over 7000 hours of flying experience. He is a Qualified Flying Instructor and has also been an Air Force Examiner. He has held various appointments which includes Chief Operations Officer of a Transport Base, Commanding Officer of a Strategic Airlift Squadron, Director Operations (Transport) at Air Headquarters, Air Officer Commanding of Air



Force Station Chandigarh, Assistant Chief of Air Staff (Personnel Airmen and Civilians) and Assistant Chief of Air Staff Operations (Transport and Helicopters) at Air HQ before assuming the present appointment.

He is Commodore Commandant of No 44 Squadron, flying Ilyushin Il-76s.

P Jayapal appointed Chief Executive, CEMILAC

P Jayapal has taken over as the new Chief Executive, Centre for Military Airworthiness and Certification (CEMILAC), Bangalore, assuming charge from Dr. K Tamil Mani, who was holding the additional charge as CE, CEMILAC subsequent to his elevation as DG (Aeronautics). An alumnus of MIT, Anna University, from where he obtained his B.Tech in Aeronautical Engineering and his Masters, he joined the Defence Research and Development Organisation (DRDO) in 1985 at the Regional Centre for Military Airworthiness (RCMA) in Nasik. He subsequently moved to RCMA (Helicopters), Bangalore before being elevated to Group Director (Aircraft) in CEMILAC, Bangalore.

As Chief Executive (Airworthiness) he will be responsible for overseeing the Airworthiness Clearance Certification activities on various projects including LCA, ALH, HJT-36, UAVs and several major upgrade programmes for the armed forces. The Chief Executive is also responsible for monitoring all airworthiness activities of the 14 RCMAs situated all over India and assuring flight safety of all Military Airborne Vehicles.

Rafales to participate in Exercise Garuda

A ccording to sources in New Delhi, Rafale fighters of the *Armee de l'Air* will participate in the forthcoming joint Indo-French 'Exercise *Garuda*', to take place from 2-13 June 2014 in Jodhpur. The fifth edition of *Garuda* will see Indian and French Air Forces engaged in various missions ranging from close combat engagement of large forces, slow mover protection, and engaging high-value aerial assets. According to IAF, the objective of the exercise is "to expose IAF pilots to French fighter tactics and vice versa, carry out dissimilar air-to-air refuelling, cross-servicing of a common type between ground crews and so on." The French participation will include four Rafale multi-role fighter aircraft and an air-to-air refueling aircraft, supported by over 100 personnel. Exercise *Garuda* has previously been held at various other locations, including Istres in France and Gwalior in India.



Pilatus PC-7s at AFA

The Indian Air Force's PC-7 Mk.II fleet at the Air Force Academy (AFA), Dundigal has achieved more than 12,000 flying hours and accumulated over 24,000 landings, since the first delivery of the new Basic Trainer Aircraft (BTA) to the Indian Air Force in February 2013.

As of April 2014, the Indian Air Force had taken delivery of 35 PC-7 Mk.II aircraft and the remaining 40 aircraft are being flown-in on a monthly basis under the accelerated delivery schedule. In March this year, the first PC-7 Mk.II Fixed Base Full Mission Simulator became operational at Dundigal with a second simulator and additional Ground-Based Training Systems due to be installed by the end of this year.



AOC-in-C Training Command with Commandant AFA and PC-7 Mk.II at AFA Dundigal

HAL's turnover crosses Rs. 15,000 Crore

Financial Year 2013-2014 ended with HAL recording a turnover of Rs. 15,180 crore, as against the previous year's Rs. 14,324 crore. "We crossed the psychological barrier of Rs. 15,000 crore... produced 60 aircraft and helicopters, achieved the Initial Operational Clearance (IOC-II) of LCA and filed a record 209 patents during the year," said Dr RK Tyagi, Chairman, HAL. "We are preparing the company for 2020 and beyond." HAL's Value of Production (VOP) for FY 2013-14, stood at Rs. 15,296 crore as against the figure of Rs. 14,202 crore for the previous year. The operating profit went up to Rs. 1,651 crore, higher than last year's figure of Rs. 1,194 crore.



HAL-built Hawk Mk.132 of INAS 551 at Vishakhapatnam

HAL also received the 'Most Efficient *Navratna* 2013' award from the Dalal Street Investment Journal. Other achievements of HAL in FY 2013-14 included sea level, night and high altitude trials of the HJT-36 IJT, induction of first indigenously manufactured Hawk Advanced Jet Trainer at INS *Dega*, Vishakhapatnam, contribution of structures for the Mars Orbiter Mission (MOM) and Crew Module structure assembly for the Human Spaceflight Programme (HSP) to ISRO.

Oman Air Chief visits India

A ir Vice Marshal Matar Ali Matar Al-Abaidaniw, Commander of the Royal Air Force of Oman, visited India in early April on a goodwill visit, meeting Air Chief Marsal Arup Raha "for discussions on matters of mutual interest." The IAF and the Royal Air Force of Oman have carried out several joint exercises involving Jaguars, with reciprocal visits to each country's airbases in the past many years.



Jaguar Maritimes of No 6 Squadron IAF formate with Oman Jaguars over the Arabian Sea

Indian support for Afghan National Army

To meet requirements of Afghan armed forces for a range of heavy weaponry, and in response to recent Afghan requests, the Government of India has reportedly finalised a significant deal with Russia for the supply of equipment to the Afghan National Army (ANA). Under the deal, India will finance the supply of Russian-origin artillery guns, armoured vehicles, tanks and combat helicopters to Afghanistan. India and Russia will also prepare an inventory of old Russian hardware in Afghanistan, much of it abandoned after the the Soviet Union's involvement in the country during 1979-89, for its possible refurbishment.



MiG-29 upgradation kits

"Russian Aircraft Corporation MiG has completed deliveries of modernisation kits' for IAF MiG-29 fighters", announced Director General Sergei Korotkov. Under a \$964 million contract signed in 2009, RAC-MiG were to upgrade the IAF's fleet of MiG-29s to the UPG standard, with the first six aircraft to be upgraded in Russia and balance kits sent to the IAF at Ozar first for incorporation. The six upgraded MiG-29UPGs were delivered over 2012 and 2013, three a year. Mr Korotkov stated that, "a large group of MiG Corporation experts are there. They, along with our subcontractors that participate in the project, transfer these aircraft and support the Indian colleagues."



Mr Korotkov also stated that the training of Indian naval pilots for MiG-29K carrier based fighters continues as per schedule. The second batch of five Indian pilots started their training at the Goa naval aviation test range while the first MiG-29KUB landing on the INS *Vikramaditya* by an Indian naval pilot, took place on 7 February 2014.

Final Su-30MKI to IAF by 2019

The Indian Air Force is expected to receive all 272 Su-30MKI fighters it has on order by 2019, which represents a twoyear delay from the 2016-2017 schedule initially set. Of the 272 Sukhoi-30MKI fighters on order, 222 are to be built at HAL's Nasik Division, of which 149 have reportedly been delivered. In FY 2013-14, HAL delivered 15 Su-30s to the IAF and according to sources, plan to continue producing 15 aircraft a year so as to deliver the remaining 73 aircraft by 2019.



HAL's Nasik Division is thereafter planning to manufacture the Indo-Russian joint fifth-generation fighter aircraft whose development in Russia is proceeding apace (*see World News*).

RAC-MiG to establish Service Centre in India

Sergei Korotkov, chief executive officer of Russian Aircraft Corporation MiG, has announced that a service centre for MiG-29 aircraft would be operational in India from 2015. In a contract worth \$43 million, signed at the Moscow air show 2013, RAC-MiG and Basant



Aerospace of India agreed to establish a service centre for the repair and maintenance of Zhuk-ME airborne radar systems. A second contract for \$12 million involved the creation of a service centre for the repair of upgraded MiG-29s in India. The centres will conduct refurbishment of airborne radar systems and aircraft such as the MiG-29UPG and MiG-29K/KUB and will provide advisory services on technical matters.

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Upgraded An-32s for IAF

Five modernised Antonov An-32s arrived at Kanpur from Ukraine on 29 March 2014, being the seventh batch of upgraded An-32s delivered to India, bringing the total number to 35. The last five An-32s to be upgraded in Ukraine will be delivered in summer 2014. The deliveries are part of a deal signed in 2009 between the Ministry of Defence and *Spectechnoexport* for the modernisation of 105 An-32s. As per the contract, 40 were to be upgraded at Aviation Repair Plant 410 in Kiev, with the rest at No.1 Base Repair Depot at Kanpur-Chakeri. The upgraded aircraft feature new avionics and improvements to their ZMKB Progress AI-20DM turboprops.



Bhatinda first 'MAFI' upgraded IAF airfield

Under the *Modernisation of Airfield Infrastructure* (MAFI) project, which involves modernisation of 67 military airfields in India to facilitate operations in all-weather and visibility conditions, Air Force Station Bhatinda is the first such to be upgraded. By



VCAS Air Marshal RK Sharma commissioning the MAFI at Bhatinda

end-2016, 30 IAF and IN bases, including 8 along the Sino-Indian border, will have been modernised to a level where aircraft can take off and land in visibility as low as 300 metres. As part of the MAFI project, Bhatinda has been equipped with an Instrument Landing System that permits Category II landing, among other advantages. The Rs 2,500 crore MAFI project was globally tendered, and won by Tata Power Strategic Electronics Division.

The IAF's ability to conduct air operations safely in poor weather and visibility would be enhanced further by end-2019, when 37 more air bases (including two under the Ministry of Home Affairs) would have been upgraded to MAFI standards. As a backup, MAFI caters for a Category II airfield lighting system, which deploys runway lighting in a particular pattern that guides aircraft to the touchdown point. MAFI also provides two 750 KVA generators that can provide load for all electrical and electronic equipment in the event of a power failure.

Unfortunate loss of IAF C-130J

O n 28 March, one of the IAF's recently acquired C-130J Super Hercules of No. 77 Squadron crashed some 115 km west of Gwalior, this aircraft (KC-3803) being part of a two aircraft formation practicing low-level operations. All five of the crew perished in the crash. Preliminary findings of an inquiry suggest that the aircrew may have lost control on entering the mammoth wake generated by the lead C-130J ahead of it. Flying into an area of turbulent air caused by wake vortices impacts the lift generation capability of an aircraft, causing loss of control.



Tail of the crashed C-130J near Gwalior, with IAF Dhruv in the background

IAF to set up DNA databank

The Indian Air Force has initiated a project to maintain DNA records of every crewmember who faces potential 'threat to life' during everyday operations. The project, undertaken by the Directorate General of Medical Services (Air), was accelerated after a Mi-17 crashed in Uttarakhand during rescue efforts in 2013. DNA samples of over 2500 crewmembers are being collected as part of the first phase, though this could be expanded across the force later. Attention is also being given to DNA profiling of aircrew from the Army and Navy.

Panasonic

Bombardier Global 5000s under special conversion

Two Bombardier Global 5000 aircraft for India are being converted for multi-spectral intelligence surveillance and reconnaissance and were seen during crosswind-landing tests at Keflavik in Iceland and Prestwick in Scotland during the first week of March (see picture). The Bombardier Global 5000s are being converted to the role by Elta Systems of Israel under a \$300 million contract signed in June 2013. The aircraft had earlier arrived in Israel and following tests, are to be delivered later this year to the special Aviation Research Centre under the Cabinet Secretariat.



Navy's appreciation for HAL

Vice Admiral Shekhar Sinha, former Flag Officer Commandingin-Chief, Western Naval Command and then IN's 'Grey Eagle' lauded the role of Dhruv helicopters and stressed the close ties between the Navy and HAL. Vice Admiral Sinha had earlier complimented HAL during commissioning of INAS322 which "has brought Dhruv helicopters more in focus towards their effective operational utilisation and maintenance. HAL has been highly instrumental in making this a reality and speaks volumes about HAL's commitment towards nation building through indigenisation. The Indian Navy is proud of its close association with HAL, nurtured over long years of mutual trust in operation and maintenance of our frontline assets."



Astra test fired from Su-30MKI



Astra, the indigenously developed Beyond Visual Range (BVR) Air-to-Air missile was successfully test fired on 4 May 2014 from a Su-30MKI at a naval range off Goa. Designed and developed by DRDO, the Astra possesses high *Single Shot Kill Probability* (SSKP), being an all-aspect missile with active radar terminal guidance, ECCM features, smokeless propulsion and process improved effectiveness in multi-target scenarios. Avinash Chander, Scientific Advisor to the Defence Minister and DG, DRDO, congratulated the team for their high competence and tenacity to make such an event happen seamlessly. "This will be followed shortly by a launch against an actual target. Many more trials are planned and will be conducted to clear the launch envelope. Weapon integration with 'Tejas' Light Combat Aircraft will also be done in the near future," he said.

Commanders' Conferences in New Delhi

A series of Commanders Conferences took place in New Delhi during April and May 2014 (see photos below).



The Chief of the Army Staff, General Bikram Singh with Army Commanders and PSOs at the Manekshaw Centre in Delhi Cantonment.



Air Chief Marshal Arup Raha, CAS with AOC-in-Cs and PSOs at Vayu Bhawan.

Coast Guard Station commissioned at Frazerganj

ICGS *Frazerganj* was commissioned as a new Forward Operating Base (FOB) in the South 24-Parganas district of West Bengal on 14 April 2014. ICGS *Frazerganj* is the 42nd Indian Coast Guard Station and will serve as a hub for coastal security operations in the areas off the Sunderbans.



The station will act as a Forward Operating Base (FOB), using recently acquired hovercraft to enhance surveillance in the Sunderbans areas and along the notional IMBL with Bangladesh. ICGS *Frazerganj* will also be a hub for coastal security operations in coordination with the State Administration, Police, Customs, Fisheries, Forest Department and other agencies including local fishermen to achieve an effective surveillance and security network. In addition, various maritime operations like anti-poaching, search and rescue, pollution response and anti-piracy will also be their mandate.

MBDA-ISAE Scholarship awardees

The Ambassador of France to India, François Richier and Loïc Piedevache, MBDA Country Head India, hosted a reception for the first group of Indian students who have been awarded scholarships under the MBDA 'Programme of Excellence'. They will



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be embarking on a two-year Master's programme at the prestigious French university *Institut Supérieur de l'Aéronautique et de l'Espace* (ISAE) located in Toulouse, southern France. In December 2013, MBDA had signed a sponsorship agreement with the ISAE-SUPAERO Foundation and ISAE, thereby setting up the Indian scholarship programme.

After completing their studies, the students will be awarded an internationally recognised MSc in Aerospace, Mechanics and Avionics. As the Ambassador said, "All engineers contribute to their nation's technological and industrial progress. The bright young Indian students who have been chosen by MBDA and ISAE will do even more. They will play their part in preparing the future of the relationship of France and India."

Distinguished and Gallantry Awards

During defence investiture ceremonies held on 22 March 2014 and 2 May 2014, senior officers of the armed forces were honoured with awards for gallantry and meritorious service. Strategic Forces Commander Vice Admiral SPS Cheema was awarded the Param Vishisht Seva Medal, while Vice Admiral Anurag G Thapliyal, Director General Indian Coast Guard, was awarded bar to AVSM. Air Force recipients of the PVSM were Air Marshal DP Joshi and Air Marshal RK Sharma.



Army officers honoured with the award of PVSM included Lt Gen Dalbir Singh, Lt Gen Sanjiv Chachra, Lt Gen Narendra Singh, Lt Gen Jai Prakash Nehra, Lt Gen Shakti Gurung, Lt Gen SH Kulkarni, Lt Gen Subroto Mitra, Lt Gen Raj Nandan Singh, Lt Gen Vinod Bhatia, Lt Gen Ashok Kumar Choudhary, Lt Gen Ashok Singh, Lt Gen AS Chabbewal, Lt Gen Narendra Bahadur Singh, Lt Gen Anil Singh Nandal, Lt Gen Ranbir Singh, Lt Gen Sanjeev Anand, Lt Gen Surendra Singh Panwar and Lt Gen Ajit Singh Narula.

PLA delegation visits India

A n eight member Chinese delegation of the PLA, led by Lieutenant General Qi Jianguo, Deputy Chief of General Staff (Operations), arrived in New Delhi on 22 April for a two day visit, in response to an invitation extended by the Government of India.

Official talks with the Chinese delegation took place in South Block where the two sides exchanged views on various issues of



Chinese and Indian Army officers at South Block

mutual interest including maintenance of peace and tranquility along the Line of Actual Control and enhancing mutual cooperation and understanding between the armies of India and China.

Concurring on the need to enhance bilateral military engagements, the Chinese side confirmed their participation at the Fourth India China Joint Training Exercise to be held in November 2014. The PLA Delegation also called on the Chairman Chiefs of Staff Committee and Chief of the Army Staff, General Bikram Singh and the Defence Secretary.

INS Shivalik in China

INS *Shivalik*, India's first indigenously-built stealth frigate, visted Qingdao port in eastern China from 20 April 2014 as part of exercises marking the PLA Navy's 65th anniversary. Other naval warships were from China, Pakistan, Bangladesh, Singapore, Brunei, Malaysia and others. The exercises involved search and rescue, joint communication and coordination. The US had reportedly not sent any of its ships, while Japan was not invited due to 'its erroneous policies over the disputed islands in the East China Sea,' according to a Chinese naval spokesperson.



While Chinese naval chief Admiral Wu Shingli was invited for a tour of the *Shivalik*, his unusual request to visit the frigate's Combat Information Centre (CIC) was turned down by the CO Captain Puruvir Das.

Chinese Naval ships visit Vishakhapatnam

A month later, two Chinese naval ships docked at Eastern Naval Headquarters, Vishakhapatnam as part of a goodwill tour. Chinese missile frigate *Weifang* was joined by naval training vessel *Zhenghe* as the two ships arrived at Vishakhapatnam port on the evening of 17 May 2014.



Indian Naval delegation in Vladivostok

A n Indian naval delegation visited the Russian far-eastern city of Vladivostok in April for preparatory talks on the Indo-Russian naval exercise *Indra* (*Indra* is a portmanteau of India and Russia), to be held in July 2014. Four Indian warships are scheduled to take part in the exercise *Indra*, to be held in the Sea of Japan in mid-July. The biannual exercises commenced in 2003 when warships of the Russian Navy engaged in a number of exercises with the Indian Navy. The last edition of *Indra* was held off Mumbai in December 2012.

ISRO launches IRNSS-1B satellite

n 4 April 2014, ISRO's Polar Satellite Launch Vehicle was launched from Sriharikota to successfully put into orbit the

IRNSS-1B satellite. Weighing 1432kg, this is the second of seven satellites in the Indian Regional Navigational Satellite System, the first having been launched on 2 July 2013. Once the constellation of seven satellites is in orbit, the system will provide positioning information in the Indian region and 1500 km around the subcontinent, thus obviating the use of foreign Global Navigation Systems. IRNSS would provide two types of services, namely, Standard Positioning Services (SPS) - provided to all users - and Restricted Services (RS), to only authorised users.



Agni 1 test launched

The Strategic Forces Command (SFC) test-launched an Agni 1 ballistic missile from Wheeler Island, off the coast of Odisha. The test, which took place on 11 April, was the first night trial of the Agni 1, which reached its pre-designated target point in the Bay of Bengal "meeting all the mission objectives successfully." Two downrange ships recorded the terminal event as the missile splashed down into the sea, while the entire trajectory was tracked and monitored by radars, the electro-optical network and telemetry stations along the east coast. Agni 1 is a medium range ballistic missile developed by the DRDO, and part of the armed forces' arsenal.



Predictably, Pakistan test fired their Hatf III surface-to-surface short-range ballistic missile soon after, twice on 22 April and 8 May 2014 (see below). The Hatf III is capable of carrying nuclear and conventional warheads up to a range of 290 km.



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Maiden launch of PDV interceptor

In a significant step to develop a two-layered ballistic missile defence system, the Prithvi Defence Vehicle (PDV), which is capable of intercepting targets outside the earth's atmosphere, was test-launched on 27 April and intercepted the test target which had been launched from a naval ship in the Bay of Bengal.

A statement from DRDO said that radar-based tracking system had detected the approaching target, relaying the data to computer networks that accurately mapped trajectory of the missile. On receiving the necessary command for lift-off, the PDV, guided by high-accuracy Inertial Navigation Systems (INS) and supported by a Redundant Micro-Navigation System, moved towards the point of interception. On crossing the atmosphere, the heat shield and infrared seeker dome was deployed as planned.

The missile intercepted its target at a height of 120km, the entire sequence of events being automated. DRDO has previously tested six interceptor missiles designed to intercept targets both in the endo-atmosphere (within 30km altitude above sea level) and exo-atmosphere (above 30km).



Akash Air Force version test fired

Two Akash missiles were test fired in separate test modes on 26 April 2014, successfully intercepting fast moving targets towed by Lakshya pilotless target aircraft. These two missiles were Air Force versions randomly picked from series production. The Indian Air Force has planned to induct eight squadrons of Akash SAMs while the Army has placed an order for two regiments of Akash missiles. Bharat Electronics Limited (BEL), Bangalore is producing the Air Force variant of the missile, while Bharat Dynamics Limited (BDL), Hyderabad, is meeting the Army's requirement.



SIA begins A380 operations to India

S ingapore Airlines initiated regular services to and from India with the mega Airbus A380 airliner from 30 May 2014, with flights from Delhi and Mumbai to Singapore. The airline now operates one A380 flight each from Delhi and Mumbai, replacing the two daily Boeing 777 flights to the island nation. A third Boeing 777



flight from Delhi will, however, continue to operate until 1 July, when it is slated to be replaced by an Airbus A380. The SIA A380s are designed to carry 471 passengers in a three-class configuration of first class suites, business class and economy.

Singapore Airlines is not the only carrier who intends to use the A380 in India. Emirates announced that it would commence A380 flights to Mumbai from July.

AirAsia India takes delivery of first A320

Chennai-based AirAsia India has taken delivery of its first aircraft, an Airbus A320 equipped with sharklets, becoming the newest operator of the type. There are an additional nine A320s on order, all



Note Indian flag below cockpit

powered by CFM engines, the aircraft configured in an-all economy layout with 180 seats. The new airline is a joint venture between AirAsia Group, Tata Sons and Telstra Tradeplace, whose CEO Mittu Chandilya is "fully confident that with our new A320 fleet we will provide Indian passengers the service and convenient travel options already offered by AirAsia Group elsewhere in the region." On 6 May 2014, AirAsia India was granted an Air Operators Permit by DGCA, clearing the deck for the airline to begin operations.

AirAsia India's fleet will be drawn from the 475 A320 family airliners ordered by the AirAsia Group. To date, almost a third of the aircraft on order have already been delivered and are flying as part of AirAsia Group's operations from Kuala Lumpur, Bangkok, Jakarta, Manila and now Chennai. The AirAsia Group has also ordered 51 A330s and 10 A350 XWBs for its long haul affiliate AirAsia X.

BAOA optimistic on growth of business sector

The Business Aircraft Operators' Association (BAOA), has called for a separate regulatory framework for general aviation "to remove long prevailing bottlenecks for the sector to grow in India." Taking into account the retarded growth over the last 2 years, BAOA has emphasised on the need for a favourable environment for



operations through compliances for general aviation being brought at par with scheduled airlines.

"There is an immediate need to address some of the issues adversely affecting operational efficiency of non-scheduled and private operators owing to airlines specific regulations and circulars being applied to NSOP and private operators without considering the different environment and operating conditions of these aircraft. This has led to inhibiting growth potential of the general aviation and business aviation sectors, besides negatively impacting job creation," observed Rohit Kapur, President, BAOA.

GE Aviation and AAI in collaboration

GE Aviation is providing technical support to the Airports Authority of India (AAI) to accelerate deployment of Required Navigation Performance (RNP) flight paths throughout India. Through a US Trade and Development Agency (USTDA) grant, GE Aviation and AAI "will work together to deploy efficient procedures at Bengaluru, Mangalore and Guwahati airports to improve airspace efficiency." GE will also work with Directorate General of Civil Aviation (DGCA) to support RNP operations approval for an Indian airline. Once the flight paths are deployed and in use, a report documenting the actual benefits of the flight paths will be published.

"India has more than 50 mid-sized airports, including Mangalore, which could benefit immediately with track mile and fuel savings from RNP," said Giovanni Spitale, general manager of GE Aviation's Flight Efficiency Services. "In the long term, India could see yearly consumption of fuel go down by 80,000 tons while CO_2 emissions reduce by 252,000 tons annually by implementing RNP across the country."

Modernisation of India's ATM infrastructure

The market for Air Traffic Management (ATM) equipment and services in India will be worth \$1.28 billion between 2015

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and 2019." According to a comprehensive new study, the market in India is being driven by three main factors: requirements to supply 50 new low-cost airports with navigation, communication and surveillance equipment; the equipping of new consolidated en-route centres and the introduction of next-generation systems such as ADS-B and precision satellite-based navigation concepts.

"India is modernising its ATM infrastructure at a remarkably fast rate," said Philip Butterworth-Hayes, author of the report. He also stated "India has embraced the latest ICAO Global Air Navigation Plan to harmonise its development with programmes in Europe and North America."

GoAir conducts eTaxi trials

As per the Memorandum of Understanding between EGTS International (a joint venture of Safran and Honeywell) and GoAir, the Indian carrier will conduct trials of the Electronic Green Taxing System (EGTS) being developed for the Airbus A320ceo. EGTS functions by using the aircraft's auxiliary power unit to drive electric motors fitted to the main landing gear wheels, enabling the aircraft to push back from the gate without a tug and taxi to and from the runway without using its engines. Trials with GoAir are expected to advance development of the system, establish standard operating procedures and calculate operational savings for operators. Unlike nose wheel motors previously promoted, EGTS motors are designed for the main landing gear, thereby generating enough traction to mitigate the use of engines during taxiing in all weather conditions and at all airports. The agreement with GoAir follows a December agreement with Airbus to evaluate EGTS as an option for A320 airliners.



ASM in Indian market

The ongoing IPL has provided opportunities to several companies that facilitate flight support services, Aviation Services Management (ASM) being amongst them. As one of the leading players in this segment ASM is looking at major expansion plans and India, being a rapidly growing market is an attractive destination for the company.

Vito Gomes, Founder & Managing Director, Aviation Services Management is confident that, "being part of the IPL allows us an opportunity to showcase our services to a large cross section

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of potential clients. We have been present here for a long time and have understood the market and clients needs."

Aviation Services Management (ASM) is a leading brand in the flight support industry, providing a wide range of specialised aviation services designed to offer both value and convenience to business and commercial aviation companies.



Vito Gomes, Founding & Managing Director, Aviation Services Management

Arijit Ghosh is President Honeywell Aerospace India

A rijit Ghosh has taken over as President of Honeywell Aerospace India and will oversee all strategic business elements relating to the operation of Honeywell Aerospace's business in India. He was previously Country Head for Defence and Space (D&S) in India, where he was instrumental in driving key growth and business objectives for Honeywell's Defence and Space unit within the country.



Go-ahead to Tata-SIA

F ormer Minister of Aviation Ajit Singh had granted the 'No Objection Certificate' (NOC) to the Tata-Singapore (SIA) Airlines Joint Venture on 2 April 2014, paving the way for Tata-SIA to obtain an air operator permit (AOP) from the DGCA. The NOC follows mandatory clearance from the home ministry for its three directors, Chairman Prasad Menon and Mukund Rajan from Tata, and Mak Swee Wah nominated by SIA. The Tata-SIA joint venture involves setting up of a Delhi-based full service carrier with an initial investment of \$100 million, with 51% stake being held by Tata Sons and the remaining by Singapore Airlines.

SpiceJet's Q400 "operational costs"

Sanjiv Kapoor, the new CEO of Spicejet has raised concerns over the high maintenance costs of the Q400 turboprop airliner on which SpiceJet spent Rs. 673 crore on maintenance during the last financial year. The average maintenance cost of the 70-seater Q400 is reportedly \$800 per flight hour, but in the case of SpiceJet, the cost is much higher than expected. SpiceJet operates a fleet of 15 Bombardier Q400s to connect tier-II cities, including Dehra Dun.

IMS Vikrant gets another lifeline

The Supreme Court has turned down a Bombay High Court ruling to consign the IMS (Indian Museum Ship) *Vikrant*, India's first aircraft carrier, to the scrap yard. On 5 May 2014, Justice KS Radhakrishnan ordered a status quo on the entire matter until the next hearing. This gives other state governments or port trusts that wish to adopt the aging aircraft carrier and revive it as a museum an opportunity to do so.



IMS Vikrant in the naval dockyard, Bombay

Following years of operation as a museum ship, the Maharastra government expressed its inability to preserve *Vikrant* as a museum ship due to financial constraints. The 'Save Vikrant Committee', a group of activists, have attempted to save the ship and accord it the status of 'Antiquity' under the Antiquity and Art Treasures Act, 1972. The ship was due to be scrapped on 17 May 2014 after it had been sold for a sum of Rs. 60 crore.

"Non-contact wars in the future:" DRDO chief

A ta function held at IIT Madras on 17 April 2014, Dr Avinash Chander, DG DRDO stated that all future wars are predicted to be "non-contact wars". The DRDO is focusing on developing robotics, underwater vehicles and unmanned systems. The organisation had done sufficiently well in radar systems such that 80 percent of such equipment for the armed forces is provided by the organisation. He stressed that educational institutions must focus on innovation and not on merely repeating and reproducing results. "We have been excellent survivors. India has been surviving in technology. India should now be a leader in technology," he stated.

STOP PRESS Arun Jaitley is Finance and Defence Minister

Following his swearing in as Prime Minister on 26 May 2014, Narendra Modi announced Arun Jaitley as the Finance Minister, with additional charge for Defence, which in own words, " is temporary". A lawyer by training, Arun Jaitley held several portfolios in the Atal Bihari Vajpayee government, including law, justice and company affairs. He graduated from the Shri Ram



College of Commerce before studying law at Delhi University. Mr Jaitley is serving his third term as a Rajya Sabha member and has been leader of the Opposition in the upper house for the past five years.

Rao Inderjit Singh is MoS Defence

Rao Inderjit Singh the MP from Gurgaon was appointed as Minister of State for Defence and will have independent charge as MoS for Statistics and Planning. He had earlier served as Minister for State for Defence during the UPA-1 Government and later switched from the Congress to BJP, in December 2013.



Exercise Sagar Kavach

This bi-annual maritime coastal security exercise introduced post-26/11 was conducted on 21-22 May 2014 across the State of Gujarat and the coastline of Daman & Diu. Coordinated by the Coast Guard Regional Headquarters (NW), Gandhinagar, the maritime security exercise was conducted to ascertain the preparedness and synergy between coastal security stakeholders.

The exercise involved ships and aircraft of the Coast Guard and Navy, UAVs of the Navy, Air Force and Gujarat Police, Police Commandos and patrol boats of the BSF, Marine Police and Customs. In addition the Port Security Boats and Harbour Tugs were also deployed for the exercise. "The efficacy of men and material was put to test for alertness towards gap free coastal security apparatus to prevent any infiltrations by non-state actors in our coastal areas", according to the spokesman.





onducted over the course of two weeks in May 2014, Exercise *Sarvada Vijay* was held as part of routine training where elements of the Army practiced and honed their war fighting skills. The overall aim of the exercise was to practice conventional cross-border thrusts into enemy territory. The exercise involved the Mathura-based I Strike Corps with some 20,000 troops, over 200 tanks, armoured personnel carriers and howitzers employed. Composite infantry and mechanised forces practiced swift manoeuvres as part of the exercise.







Networked radars, Unmanned Aerial Vehicles and aerial surveillance platforms ensured continuous flow of information resulting in battlefield transparency that enabled Commanders to assess and suitably modify their operational plans to meet the emerging challenges. Mobile communication systems integrated with terrestrial network provided efficient communication during manoeuvres. The Army also reviewed the command and control structures that facilitate synergy between Army and Air Force in launching a coordinated air-land battle. The ability to orchestrate battle in a network centric environment was also successfully validated.



The Government of Pakistan had in advance been informed of the conduct of such a massive exercise near the International Border. Following Operation *Parakaram*, much importance has been given to troop mobilisation along the border, with the Jaipur–based South Western Command being created in 2005, 1 Strike Corps falling under it. Exercise *Sarvada Vijay* was conducted at the Mahajan Field Firing Range near Suratgarh. Lt Gen AK Sahni, GOC-in-C South Western Command, witnessed conduct of the exercise, alongwith Air Marshal Ravi Sharma, the VCAS.



Strategy for equipping the Indian Army

Indian tank in the desert : the T-72 remains backbone of the armoured forces

ndia's capital defence budget has been growing at a meagre percentile planon-plan over the past two decades. The tardy progress in defence modernisation, capability building and capacity enhancement has been further accentuated by a defence procurement system, which is craving for increased transparency, accountability by decision makers and above all, indigenisation. In such a present - and futuristic-scenario, there is need to evolve and implement an efficient equipping strategy for the Indian Army to achieve the three-fold objective : conserve capability, exploit the inherent stretch potential of present equipment and be economically wise in defence spending. Such strategy will also need to achieve balance between effectiveness and affordability.

An effective equipping strategy must ensure that the armed force is also capable of operating with the right amount, types and modern equipment to meet its mission requirements in combat, training and internal security roles.

Challenges

The challenges faced in Equipping the Indian Army have significantly changed over the past years and the manner in which we equip the force have changed even more significantly. The challenges that dictate such an equipping strategy are :

Modernisation and Recapitalisation: The Army constantly needs to manage obsolescence by recapitalising aging equipment so as to preserve equipment and also ensure future capabilities. Equipment inventories will therefore need to be an optimum mix of new, fully modernised equipment and operationally acceptable substitutes.

Necessity to Adapt : With evolving geopolitics of the region as well as the global

arena, coupled with the advent of advanced technologies there has been a consequent change in our tactics and doctrine. It is imperative to Enhance equipment capabilities and avoid 'adhocism' which requires a dedicated assembly of personnel and equipment.

Growth and Accretions: Equipping norms have been challenged with growth in equipping requirements for accretions and new raisings. Weapon and Equipment Training (WET) of units/formations have been revised at least two to three times in the past two decades, which has meant enormous increase in the range and depth of inventory. This growth can also be measured in the increased demand for technology and the need to equip soldiers for performing decisive, shaping and sustaining operations with the required survivability and lethality to operate in today's battlefield environment. Further, with no classical "rear areas" in the

Rafael



present battlefield, the soldier's individual equipment needs to provide a base level of protection and lethality. The requirement of accretion forces also needs to be factored in to ensure their operational readiness.

Equipment Management and Sustenance in a Hostile Operational Environment : The protracted and prolonged engagement of the Indian Army in CI/CT operations and greater demands on LOC/LAC border management impose bigger challenges to equipment management including that of repair and maintenance. The increased usage of equipment has resulted in enhanced usage rates up to five or more times greater than the rates initially planned for at the time of equipment acquisition.

Budgetary Constraints : An emerging reduction in resource availability along with constant increase in operational requirements compound the Army's challenge to equip the force. We therefore must continue to adopt new ways to conserve resources while preserving the decisive edge for combat.

Present System

The present system of equipping the Indian Army is based on Weapon & Equipment Table (WET) authorisations approved by the Government for each unit/formation. All units/formations are required to be operationally ready at all times and thus work out their holdings/serviceability based on this mother document. The impending/current tasking/roles have no implications on the equipment required to be held.

The present situation is such that probably no unit/formation is fully equipped. Both intrinsic and extrinsic factors viz. inventory, obsolescence and technology management along with the slow pace of induction of new acquisitions of weapon systems and platforms directly impact on equipment holdings with units. Further, sustenance issues often contribute to reduced serviceable equipment availability particularly with respect to complex weapon systems procured ex-import.

The US Model : A Rotational Equipping Strategy (RES)

To meet demands of the past decade of conflict in Iraq and Afghanistan, the US Army has graduated from the erstwhile traditional Cold War Era strategy to a full spectrum Army Force Generation (ARFORGEN)-based strategy referred to as RES. Such a model equips units in different manner based on their designated state of readiness, the objective being to equip a rotational force, at minimal cost, while preserving capacity and capability. The RES is pre-dictated on equipment being available somewhere in the Army for surge deployment along with the associated functional logistic linkages. The various states of readiness that a unit may be designated under the RES are as under :

Reset: Units in 'Reset' are equipped with minimal specific equipping expectations. However, this does not imply that they are devoid of equipment. Units in this state have much, but not all, of their individual equipment and other equipment that is not subject to 'Reset'. The Army delivers equipment to units following the Reset phase to prepare them for entry into the 'Train' state. This requires synchronisation with the arrival of new personnel into the unit, to ensure that the unit is prepared to receive, account for, store and maintain the equipment.

Train/Ready : The Army provides equipment judiciously to units to support their training requirements and ensure that it can adequately equip units in the other force pools. Units in 'Train/Ready' pool can expect to enter this phase filled to about 80 percent of their Unit Modified Tables of Organisation and Equipment (MTOEs) authorisation, akin to IA WET. As units approach the 'Available' phase, they adjust their equipping levels to meet the specific requirements of their designated/impending mission.

Availability : Units entering the 'Available' phase are equipped to 'ninety percent-plus' of their MTOE authorisations based on their assigned mission. Some equipment authorisations are specific to a mission and are not authorised in MTOE. In such cases the final equipping is provided by Theatre Provided Equipment (TPE) specific to a theatre of operation.

The US Army RES is not only a significant change in how an army equips units but also how the commanders view their units and organisations. It involves a change in the unit/ organisational culture towards equipment management and training, which impacts efficacy of force structuring and equipping.

Relevance for the Indian Army

Although the US Army RES has no immediate relevance to the current threat based capability approach and force structuring of the Indian Army, even more so when there are major equipment voids in the inventory, but as we graduate to a capability based approach we can draw useful lessons from the US equipping strategy. This will align our stated doctrine with the desired capability.



The Saab Carl Gustav is a very potent anti-tank weapon and is standard with Indian Army Infantry units.

As a precursor an RES may be considered for certain components of the Indian Army as we transition to a threat-cum-capability based force, where the airborne/amphibious components of the force structure may be enlarged based on rotation equipping plans, with a mission ready/deployable force being equipped to its complete operational requirement, while the reserve component may be kept in the 'train/ready' state. Similar strategy may also be applied to CBRN-enabled forces/assets in view of the limited equipment holdings and capital intensive equipping and training processes.

The implementation of an effective equipping strategy may be a measure of success by contributing to the overall readiness of the Indian Army while being conscious of the costs. As we move toward the goal of increased readiness, the Army should have clear expectations regarding what levels of equipment they will receive – and when. Commanders and staff also need to have a clear understanding of how to allocate equipment most efficiently and to effectively support the Army's training and readiness targets.

Bikramdeep Singh (CLAWS)



Rafael from Israel provides ideal short range air defence solutions



VAYU's Interview with HE Mr Alexander Kadakin, Ambassador of the Russian Federation to India

VANU: You have long witnessed many cooperation programmes between our two countries. How would you describe development of cooperation in the military sphere and its progress?

AK: Indeed, practically all my diplomatic career is connected with India, starting from 1971. During such a long time, drastic changes have happened in international relations. Today our longstanding friend, great India, is confidently gaining power and authority as a world player and has become one of the largest importers of defence products. At the same time the political and military leaders of the country are looking at diversifying the sources. Such an approach is completely understandable, but this does not mean that the relations between our countries in military cooperation should be revised or devalued. The achievements and the experience gained in this key element are highly valued in India. Our cooperation has already been developing for six decades and last year itself, we supplied more than \$ 3.6 billion worth of supplies to India. This allows us to say that Russian-Indian ties in military cooperation are one of the pillars of our privileged strategic partnership.

VANU: Lately, India has chosen manufacturers from other countries. Why do you think this has happened?

AK : As I have said, the world is changing and India is changing as well, it is not like it was in the 1950s. In the defence sector the country's leadership is maturely



evaluating India's interests and priorities, choosing what best suits the existing needs and aims. Again, this is natural, and we're not jealous about it ! India's contracts with other countries have touched only specific sectors. The sheer size and scope of our work cannot be compared with single purchases.

But we certainly cannot rest on past laurels, relying on the fact that India will always meet its military needs with supplies



from Russia. Such a naïve approach nowadays is untenable. That is why we had to speed up the transition from former 'seller – customer' relations to expanded overall Russian-Indian cooperation – including joint development and production of weapons and military equipment. One great example is the Russian-Indian joint venture 'BrahMos Aerospace,' which produces the world's best supersonic cruise missiles. Experts of the two countries have been cooperating successfully in other projects like the PMF (perspective multipurpose fighter) and multi-role transport aircraft (MTA). Active participation of Russia in Defexpo 2014 in New Delhi confirmed the huge interest from our Indian partners on these projects.

VAYU: You have mentioned the PMF and MTA – what is the progress so far?

AK: Cooperation in the development of the PMF is being implemented within the framework of the Intergovernmental Agreement of 18 October 2007; from the Indian side it involves state corporation Hindustan Aeronautics Limited (HAL), and from the Russian side it is Rosoboronexport and Joint Stock Company Sukhoi. The joint project includes design and development of a new generation fighter to possess such innovative features as stealth, supersonic cruise speed, high manoeuvrability, highly integrated avionics, enhanced warning systems and internal carriage of weapons. The programme envisages creation of the PMF and integration of an advanced engine with increased thrust. Joint promotion to third countries is also planned. Planned orders for the Indian Air Force are projected at 144 aircraft and series production of the first PMF for the Indian Air Force is to start in 2020-2022.

For the moment the aircraft export concept has been approved, the general agreement is signed, and technical requirements are also approved. Both nations are now discussing the agreement on developmental work. We are very clear on implementing this major project, and talks have been going smoothly. If the project is slowing down owing to the need by India to reallocate funds to some other, majorly high priced purchases, then the Russian side is not to be blamed for the delays.

The MTA joint design and development is being carried out on basis of the Intergovernmental Agreement signed in November 2007 and provides, inter alia, the creation of the joint venture on a parity basis in India. In 2008, a first phase draft contract for MTA conceptual design was handed over to the Indian side, to HAL. The joint venture representative office was opened in Moscow in 2011. A general agreement was signed in May 2012 and preliminary design contract has been signed in October 2012. In accordance with the agreement, a joint Russian-Indian group was created. Starting from December 2012, 35 Indian experts began working at JSC 'UAC-TS' in Moscow and finished this stage in September 2013. The Parties are now discussing further agreements for R&D work. So, to sum it up, the collaboration is moving forward and we should be able to see its results soon.

WAND: What can you tell us about that most famous of Indo-Russian projects, the Su-30MKI?

AK: The Su-30MKI delivery and licensed production is one of the most significant of projects. It is carried out under an intergovernmental agreement and the general contract signed in 2000 worth more than \$3.34 billion. The contract, which involved Rosoboronexport, Irkut Corporation and HAL, provided for the transfer of licenses and technical documentation and delivery of component kits for the production of 140 Su-30MKI fighters.

The project is divided into four phases. At first the aircraft was to be produced entirely by Irkut and then delivered to HAL for flight testing and after that handed over to the Indian Air Force, and each subsequent phase would increase the amount of work to be done in India. One can estimate the success of the programme by the fact that from 2007 till 2012 two additional contracts for 82 more kits were signed. The contractual obligations would shortly be fulfilled by the Russian side.

As for the modernisation of the Indian Su-30MKI fleet, it is being carried by the Indian Air Force with participation of HAL and the Defence Research and Development Organisation (DRDO) of the Ministry of Defence of India. From the Russian side it is planned that Sukhoi will work on the aircraft prototype upgrade. During the consultation process the technical parameters of the aircraft and upgrade options have been validated. Discussions on the technical and commercial aspects and preparation of contract schedule are underway.

The project to integrate the BrahMos missile with the Su-30MKI, launched in 2008 is also of major interest. The technical specification of the customised aircraft has already been approved. In October 2010, the Indian side received the draft contract. In December 2012 Rosoboronexport and BrahMos signed a contract to perform conceptual design to adapt the missile for the Su-30MKI. Executor under the contract is the Sukhoi Company. According to the managment of BrahMos Aerospace, the project is being successfully carried out, and this year the airborne version of the rocket should begin flight tests.

VANU: Could this success, from your point of view, be also achieved in other areas? We all know that nowadays one of Russia's top priorities has been commercial aircraft building.

AK : There are definitely such opportunities. The potential for collaboration is rather high. It is no secret that the Sukhoi Superjet 100 manufacturer, JSC Sukhoi Civil Aircraft, is negotiating with airlines in India to promote the aircraft. In February 2011 the aircraft took part in the Aero India 2011 show in Bangalore, and a year later in India Aviation 2012 at Hyderabad. Expert feedback allows us to give positive estimations to the prospects of our civil aircraft in Indian market, taking into consideration huge growth of passenger traffic in this region.

It is important that the Russian side should not lose the initiative in this field, and should act promptly because the competition is high. In this context, active participation of leading Russian companies in India Aviation 2014 in Hyderabad, along with SSJ100 presentations made to aviation authorities and foreign carriers as well as negotiations with potential customers concerning terms and conditions of financing and after-sales support and personnel training, receives the highest praise.

At the same time Irkut is looking for partners for MC-21 cooperation. In 2012 a cabin mock-up was presented at the India Aviation 2012 exhibition, and in 2013 there was a presentation for Indian aviation authorities and Indian carriers. At the same time, United Aircraft Corporation (JSC UAC) is looking for an industrial partner with sufficient financial resources and production experience. The negotiations with a number of private companies have already been conducted as well as with officials from the Trade Ministry. Thus, all conditions for Russian aircraft promotion are being created and we hope that this would be a success.

VAYU: We know that India is planning to develop its own civil airliner. From your point of view, would Russia take part in this project?

AK : Yes, India is planning to design and build an indigenous airliner. As part of the programme a tender for a foreign partner is envisaged. The rights for design and production are expected to be given to HAL. Taking into consideration the diverse cooperation experience between UAC and HAL, Russian-Indian partnership seems reasonable. I am convinced that further development of cooperation and expanding this to civil aviation will serve our common interests and will bring bilateral cooperation in high-tech industries to a new level.


Indian Aeronautics

at the Crossroads

Air Marshal Brijesh D Jayal writes that this is a choice between **'Reveille and the Last Post'**

recent media report indicates that HAL and the IAF have decided to work **L**out 'joint plans' to deal with military aircraft projects that are underway in the country. The report quotes the CAS as saying: "Hand-holding is important considering the challenges involved on the manufacturing and operational fronts." The report also mentions Chairman HAL touching on problems related to product support where original equipment manufacturers supply products to multiple agencies such as the Air Force, the Army, the Navy and the Coast Guard generally at different prices and terms and suggesting the "there can be greater cohesion, understanding and mutual benefits when the OEMs are dealt with from one platform," clearly indicating the need for greater integration for the common good.

The report is a pointer to the deep-rooted problems that plague the fundamentals of

operating and managing the fourth largest Air Force in the world, along with the Army and Navy with their own air wings, in concert with the indigenous defence production and R&D base to support these. For decades in its postindependence history, HAL has had virtually only one customer, the IAF. Even today it is the latter's budget that very substantially sustains HAL's business. Inexplicably, not so long ago, the MOD in its infinite wisdom decided to remove the IAF's head of planning, the DCAS, from the HAL Board instead of adding the AOM, head of engineering and support, to it.

The need for a proverbial smoking of the peace pipe by heads of two vital pillars of Indian military aviation is in no small measure due to the historic and archaic model of management of aeronautics in India that is struggling to survive in today's high technology and fiercely competitive international aeronautics market place. If nothing changes, the present agreement will amount merely to symbolism and is unlikely to survive the tenures of even the current incumbents.

Indian aeronautics – a quagmire

Whilst current writings on military and strategic affairs in India continue to limit discussion on air power to the narrow military sphere, there is much more to the aerospace age in which we live. Awareness of the all-encompassing nature of its potential, as a component of national power is yet to dawn in its entirety into the psyche of strategic security planners. It is difficult today to contemplate a modern state's economic wheels moving without application of aerospace technologies and their contribution to trade. The global village would not have been a reality without the benefits of such technologies. For India with its many developmental challenges, aeronautics offers many opportunities.

An uneasy alliance

The continuing spat between the IAF and HAL on whether the additional order for basic trainers should be through additional imports as the former would want, or through an HAL proposed design as desired by the latter, that has now spilled over to the media, indicates the depths to which the IAF/HAL relationship has descended. secured within the Russian design system and, as is now being reported, that data is not even being shared?

If reports of the IAF's reservations are indeed true, then there is hope that IAF planners, having been taken for granted for far too long, have now chosen to make a bid for the driver's seat. This was long overdue as at the end of the day, it is the IAF that is accountable to secure national air frontiers within budgets allocated by Parliament and as such they deserve to drive the technical and time frame aspects of their own procurement processes



Adding to this is a report indicating that the much heralded programme to jointly design and develop a fifth generation fighter aircraft with the Russian Federation - which has been progressing through various preliminary steps since 2008 – has hit a road block at the stage of negotiating the R&D contract. Reportedly the IAF has reservations, amongst other issues, on performance, reluctance of the Russian side to share critical design information and the high costs involved. One has never quite understood what benefits Indian aeronautics would accrue in terms of design knowhow and know-why, when it becomes a late co-partner in design with the Russian Federation after the FGFA prototypes (T.50) have already chalked up considerable flight testing. More crucially, why should India be sharing design and development costs when the crucial knowledge and design challenges to designing a fifth generation platform have already been overcome and

and to have a significant say even in the affordability of choices.

Furthermore, the fact that the IAF itself is now concerned about high costs being an input to decision-making augurs well for the entire system of planning. It is possible that faced with the reality of a ballooning bill for the proposed MMRCA programme and indeed anticipating a similar bill for the FGFA programme along with future ADA programmes, the question of affordability of procuring and maintaining their current and future air power assets is a huge challenge and receiving serious attention. Whatever the reasons, this is a welcome development and IAF planners deserve full credit and need unstinting support.

An existential crisis

It would not be an exaggeration to say that Indian military aviation today faces an existential crisis. As against the sanctioned strength of 39.5 combat squadrons, the IAF presently has 34, which will further reduce to 31 during the 12th Plan period (ends 2017). The much-delayed LCA still awaits full operational clearance and whilst the first batch of LCA Mk.1s with only 'initial operational clearance' is proposed to be inducted in limited numbers, historical experience with both the Marut and the Ajeet makes this writer wary. Although both the earlier aircraft types had potential, they had to be prematurely withdrawn from



service for reasons that will haunt the LCA programme.

Then, the MMRCA. There is little light at end of the tunnel with a formal contract continuing to be elusive whilst programme costs continue to escalate with the latest figure mentioned being US \$ 18 billion. HAL's much-promised Intermediate Jet Trainer (IJT) is further delayed and the IAF has now been compelled to explore the world market. The FGFA, LCA Mk.2, attack helicopters and medium transport aircraft are in different phases of planning and will also need to be funded and managed. The Army and Navy requirements for airborne platforms continue to remain unfulfilled.

Civil Aviation

On the civil aviation side, the demand both from scheduled and non-scheduled operators is increasing rapidly not just for additional aircraft but also for maintenance, repair and overhaul needs. In its 2012 report, the Working Group of Civil Aviation Sector (Ministry of Civil Aviation) had stated that "the potential for growth of the civil aviation sector in India is huge" and that India was likely to be "the fastest growing aviation market in the world over the next decade." It forecasts robust growth of air traffic translating into fleet requirement of about 1000 commercial airliners as against the current level of about 400 with the scheduled commercial airlines, and a total of 681 operational general aviation aircraft including 250 helicopters and 108 business jets in the country.

In order to address this potential the report had highlighted the need for a competent and skilled workforce, higher education and extensive research in frontiers of technology and science that is fundamental to long term interest of the sector, capacity to undertake maintenance, repair and overhaul tasks and, finally, an aeronautical industry capable of taking up indigenous development and production programmes for the civil sector.

The private sector – willing but ignored

The private sector has been extremely interested in exploring opportunities that would not only maximise indigenous defence production, but also lay the foundations for robust defence exports. The CII quotes in its website that "the private sector is enthusiastic about its ability to play a larger role in contributing to the total defence related production both within the country, as well as looking at export markets once sufficient experience has been gained in particular areas. The need of the hour is to combine the skills of the public and private sector, developing this into a partnership with the aim of achieving self-reliance in defence production. CII believes in creating an environment where both public and private sector grow together and partner with each other, thereby contributing towards the national growth." It further states that "this huge opportunity has attracted the attention of not only a few large players, but also a large number of Micro, Small and Medium Sized Enterprises (MSMEs)."

Unfortunately, over a decade has gone by and there is nothing to indicate that the MoD has gone out of its way to encourage, promote and nurture this flood of private sector energy that has the potential to take Indian aeronautics to its rightful place in the international market place. Whatever progress has been made, has been through private initiatives and associated international partnerships.

India's Military Expenditure - and the Arms Trade

The latest report by the Stockholm International Peace Research Institute (SIPRI), which monitors developments in military expenditure worldwide and maintains the most comprehensive publicly accessible data source on military expenditure, has reported that for 2013, the US led the world in annual defence expenditure with \$ 640 billion with China in second place at \$ 188 billion. The UK holds sixth position with \$ 57.96 billion and India is ninth, spending \$47.4 billion per year on defence. If indeed the MMRCA programme cost is close to \$ 20 billion as reported, it would amount to 40% of India's annual military expenditure for just one programme - albeit spread over time! This is a sobering prospect to which Indian security planners must give adequate thought.

For the period 2009-2013 the SIPRI list of top arms exporters puts US at first position, China at fourth, UK at sixth and Australia at twentieth. It is interesting that Uzbekistan features at nineteenth position whilst India finds no place at all in the top



twenty countries of arms exporters. Yet for the same period India tops the list of arms importing countries with a share of 14% of world deliveries. China is next with 5%, US sixth with 4% and UK sixteenth at 2%.

It is also pertinent to note that every time India features high on the international list of arms importing countries, there are well meaning articles, editorials and political voices espousing the merits of greater indigenisation to stem this unwanted tide. Unfortunately, the debate remains limited to platitudes and there is little stamina to delve deeper into the underlying causes that are at the root and to offer positive policy alternatives.

Public sector defence production

A cursory look will indicate that India's investment in the indigenous defence industry is by no means insignificant. Under the MoD's Department of Defence Production, we have a behemoth public sector defence production organisation with nine different public sector enterprises and 41 Ordnance Factories with annual 2012-13 sales of Rs 29,315.86 crore and Rs. 7100 crore respectively. In addition under the MOD there is the Defence Research & Development Organisation with nearly 50 laboratories backed by 5000 scientists and 25,000 technical and support staff.

Coming specifically to aeronautics, HAL with its nine divisions employs over 32,000 people and its sales of Rs 14,315.68 cr in 2012-13 amounts to nearly half the figure managed by all the DPSUs and Ordnance Factories combined. In addition there are six DRDO laboratories dedicated to aeronautics and an independent design authority, the ADA, whose LCA project has been long in the making. Why HAL could And true to tradition, when things begin to go wrong, as the complete paralysis that has overtaken the defence procurement system and the delayed MMRCA saga would show, the solution was to produce another



export only a paltry 2.66% of its sales and why, in spite of this huge investment India continues to be heavily import dependent not just in aeronautics, but across the entire defence sector are questions rarely asked, and whose solutions are never contemplated.

Defence Production Policy 2011

There is no one to ask these questions, because of the complete stranglehold that the MoD bureaucracy has over the entire defence acquisition and aeronautics sector. platitudinous 'Defence Production Policy 2011'. The policy indulges in high ideals, but provides no worthwhile strategic insight or action plan towards reorganisation and management of the sector.

Lukewarm attempts at reform

There have been periodic attempts at studies to look at the field of aeronautics by sector or in concert with allied issues. These efforts include the Naresh Chandra Committee on a 'Roadmap for Civil Aviation' and 'Higher Defence Management', the Rama Rao Committee on DRDO and Kelkar Committee on 'Defence Acquisitions', to name only a few. However, there has neither been any attempt to look at aeronautics in an integrated fashion nor recognition that much like Space and Atomic Energy, Aeronautics merits a similar status of an independent mission to enable integration across various agencies of government.

Any attempt to establish the Indian aeronautical industry as a meaningful player in the high technology and highly competitive international aeronautics market needs a will, a strategy, a missionoriented implementation plan and the grit to stay the course for the long haul. None of these qualities can be seen to exist in the bureaucratically-driven and strategically-barren Indian public sector aeronautics arena.



Affordability of air power financial and management challenges

If there is any consolation, it is that problems of rising costs and other challenges to air power are not restricted to India alone. As costs of airborne platforms and systems escalate inexorably and as defence budgets come under strain across the globe, air forces across the world are coming to terms that 'business as usual' is no longer a viable option. Increasing costs, not just of combat aircraft but military hardware across the board are no longer issues that responsible militaries across the western world are able to brush under the carpet any more. Countries that recognise the potential of air power as an integral component of national power - such as the USA, China and UK, among others - are investing in aerospace technological development, production and export to turn this adversity to advantage. Those that fail to grasp this technological and potent force and continue to rely heavily on imports whilst paying lip service to setting up a sound aeronautical industrial base are preparing the graveyard of aeronautics for future generations. By all accounts, India, which inherited and indeed nurtured a fairly sound aeronautical foundation in the 1950s and 1960s, has stagnated and now faces the danger of joining the ranks of lesser countries.

A USAF- and USN-sponsored RAND project in 2008 produced a report titled 'Why Has the Cost of Fixed Wing Aircraft Risen?' Two significant conclusions from the RAND study need specific mention, as there are distinct lessons for the Indian military:

- "The report finds that technical characteristics (such as airframe weight, maximum speed, and materials composition) correlate very strongly with unit price, suggesting that technical complexity is a major cost driver within the customer-driven factors. So when the IAF opts for no less than 272 Su-30MKI aircraft in the heavy 30 plus tonne class, it will continue to pay very dearly not just in acquisition costs, but the recurring cost of operating this heavy fleet."
- "The US Services have been moving toward reduced procurement quantities as a way to stay within annual procurement budgets. Recognising the technological and cost trade offs would help the Services make the increasingly difficult choices between individual aircraft capabilities and total numbers of aircraft. Again, notwithstanding the significant technology and operational performance advantages that successive generation of airborne platforms have brought to the IAF and other services, they are very reluctant to consider a trade off with approved force levels."

The Chinese approach

Recent media reports indicate that whilst speaking to defence officials on an inspection visit to Air Force Headquarters in Beijing, President Xi Jinping, who is also the Chairman of the Central Military Commission, called for "a stronger air force" and urged the air force to adopt an integrated air and space defence capability not only to boost the country's military power but to offer balanced strength in defensive and offensive operations.

Whilst China is the second highest in terms of global arms imports it has in parallel managed to cement its position as a major exporter of arms, replacing France as the world's fourth largest arms exporter, with a 6% share of international arms exports up from an earlier 2%. Significantly, China's rapidly developing military technology partly explains its expansion as an arms supplier.

Clearly, the Chinese authorities have identified air and space to be high priority areas not just from the military and security point of view, but towards a strategic plan at developing military technology, developing a sound military industrial base and use export of military hardware not just for financing their own military expenditure, but to further their economic, geo-political and diplomatic interests. Whilst this is still work in progress, as their being listed as the world's second largest arms importing



country would indicate, it has long been in the making. More crucially, the Chinese appear to be working to a well-crafted strategic plan.

The US approach

It is interesting that as far back as 2001 the US Congress had set up a Commission on the *Future of the United States Aerospace Industry* to study the future of the US aerospace industry in the global economy, particularly in relation to US national security, and to assess the future importance of the domestic aerospace industry for the economic and national security of the United States. The Commission's mission statement reads: "The Commission shall develop and recommend a series of public policy reforms that will permit the US aerospace industry to create superior technology, excel in the global marketplace, profit from investments in human and financial capital, benefit from coordinated and integrated government decision-making, assure our national security, access modern infrastructure, and give the United States a capacity throughout the 21st century to reach for the stars."

In its final report, the Commission finds that in 2000, aerospace contributed to 9% of the nation's gross domestic product and 11.2 million jobs and concludes, amongst other issues, that to achieve the aerospace vision the nation needs "a national aerospace policy and there needs to be a government wide framework that implements the policy."

That the Congress continues to monitor this vital and vibrant aerospace sector is evident from a 2009 Congressional Research Service Report (US Aerospace Manufacturing-Industry Overview & Prospects by Michaela D. Platzer) which looked at the commercial (non-defence and non-space sector of aerospace) and states "aerospace manufacturing is an important part of the US manufacturing base. It comprised 2.8% of the nation's manufacturing in 2008 and employed 500,000 in high-skilled and high-wage jobs." It then goes on to caution that challenges are looming with reducing military sales and competition from international suppliers.

The UK approach

As early as 1999 the UK MoD had set up the Defence Procurement Agency as an executive agency of the MoD responsible

for all military acquisitions in order to make the entire process cost effective. In 2008 it took another novel step by signing a private finance contract for military flying training of pilots of all the three services claiming that this partnering brought together MoD and industry skills to deliver a first class flying training capability. In 2010 the Defence Minister set up a committee to look into how to make the MoD more efficient, cut red tape and reduce inter-service rivalry. On receiving the report he said it "describes a department bedevilled by weak decisionmaking and poor accountability where there is insufficient focus on affordability and financial management." In 2012 the MoD presented a White Paper to the Parliament which set out how the MoD will procure technology, equipment, and support to meet the UK's defence needs, at a cost which is affordable and represents value for money for the UK taxpayer.

Options for India

Here are three countries : the United States, a leader in aerospace technology not content with the status quo, but strategising and planning to 'reach for the stars'; then China, a neighbour with whom India has unresolved border issues prioritising aeronautics and space and working to a strategic plan; and the UK, constantly innovating and adapting to meet the organisational and financial challenges facing the UK Ministry of Defence. In sharp contrast is India, which has the dubious distinction of being the top arms importer of the world, remaining sanguine and frozen in time. This in spite of substantial investments in defence research and production and a vibrant private sector anxiously waiting to contribute. Even as others form Congressional Committees, strategise and plan to keep up with evolving challenges, all India can produce is a Defence Production Policy which at best can compete for an English essay prize !

Against this pessimistic backdrop, it is worth reflecting on the wider Indian aeronautics landscape with regard to the state of military inventory, of R&D and the ability of the indigenous industry to support both military and civil aviation not just for economies of scale, but also to generate exports to support these needs whilst furthering our security, trade, economic and wider geo political and diplomatic interests.

At the apex

Since aeronautics plays a vital and strategic role in both the security and economic well being of the nation and requires not only vast investments but linkages across many separate government departments, agencies and the private sector, at the national level it merits a separate 'Department of Aeronautics' in the Government, coming under the Prime Minister. High technology areas of Space and Atomic Energy have followed a similar model with considerable achievement.

Aeronautics and the armed forces

If we accept that affordability must now become an input towards national air power planning, it follows that the practices that we adopt in the defence domain must meet the demanding criteria of good modern management, financial and support practices within the dictates of military operational imperatives. This must apply across the entire MoD edifice down to the user armed forces.

The first step towards this awakening is for the three services to shed age-old inhibitions of secrecy and be willing to open their own systems and processes to professional scrutiny. The security 'bogey,' when we are heavily reliant on imports, has very little credibility. The next is to look at every aspect, from how an integrated battle is planned to be fought to rationalisation of roles and missions, command and control aspects, ownership by the most cost beneficial service and allied issues of training, maintenance and product support through application of scientific and systems analysis criteria and not subjectively derived from loyalty to colour of uniforms.

Recognising that for defence ministries and the armed forces these are complex management challenges, there are international management consulting companies today that specialise in these fields and are willing to offer solutions. Fortunately, the Indian armed forces had the foresight some three decades ago to set up a College of Defence Management, which today is respected nationally. This can well be augmented to add research and consultancy faculties specific to each of the three armed services.

For any meaningful attempt to find the right balance between the desired air war fighting potential on the one hand and an affordable and self sustaining model of providing for this, the following areas merit in-depth management studies, jointly by HQ of Integrated Defence Staff at the MoD, Services Headquarters and the College of Defence Management. In select areas private consultancies could be employed for diversified skills and for time bound results. These studies should throw up various policy, organisational and management models for national security and industrial policy makers and the armed forces to consider.

Ministry of Defence

At the apex level the first to face this acid test should be the higher defence management model itself, which as is well known, is resistant to change ! HAL and DRDO-associated laboratories, including ADA should be open to part privatisation and quickly moved out of the MoD and to come under the wider ambit of the proposed National Aeronautics Policy. This will enable looking at options to blend all the national aeronautical resources, civil and military, towards higher technological innovation and research to become part of the international aeronautics value chain. It is not out of place to mention that our procurement processes, systems and expertise are all severely limited and have not changed over decades. There is an impression that having formalised a *Defence Procurement Procedure*, updating it periodically makes for professional procurement. Nothing could be further from the truth as indeed the virtual paralysis in our procurement programmes today indicates.

Arms trade in the modern world is capital- and technology-intensive as also cruelly competitive. It casts a shadow over every facet of national activity, be it defence research and development, trade, commerce, economy, security or diplomacy. It must meet clearly defined national strategic objectives. It is a task for professionals in this field and not generalist civil servants and uniformed personnel having short tenures. The American Department of Defence runs a Defence Acquisition University, whose stated mission is "to provide practitioners training, career management and services to enable the acquisition, technology and logistics community to make smart business decisions and deliver timely and affordable capabilities to the war fighter." There is need for a dedicated cadre of trained officials both in and out of uniform to 'professionalise defence acquisition'.

Ours is far from being the system that 'makes smart business decisions and delivers timely and affordable capabilities to our war fighters.'

The Armed Forces

The figure of approved combat squadrons for the IAF was arrived at some decades ago. In the interim, combat aircraft capabilities have multiplied manifold with force multipliers like FRAs, AWACS and UAVs being added. Yet there appears to be no indication of scientific trade offs between these enhanced capabilities and their numbers, as the continuing requirement of 39.5 squadrons would indicate. A similar question needs addressing with respect to army and naval air assets.

Across all the services, the weightage of manned platforms to unmanned ones also needs factoring. Arriving at force levels and performance requirements while applying scientific and cost benefit analysis



techniques to fight an integrated war and blending these with available resources is the need of the hour. To lend credence to this exercise this needs commitment not only of the Armed Forces, but also the Finance Ministry and indeed endorsement from the CCS to ensure stability of long term operational and financial planning.

That all the services need airborne resources is a no brainer. The question of how much of this can optimally be met by the IAF or any other service and how much through integration of resources avoiding duplication, needs scientific analysis and cannot be victim of parochial internal service mindsets, as is the case at present

No clear identification of airborne 'roles and missions' continues to breed unnecessary inter-service turf battles and gross wastage of valuable resources through duplication of very high value assets. Roles and missions with regard to aeronautical assets of each service now need legislative directive as has happened in the USA.

A modern combat air platform is a highly capital intensive asset. In commercial terms its lack of availability for operational usage is a waste of resources. As compared

to commercial aviation, armed forces fleet utilisation and availability rates are notoriously low. Whilst it is not the writer's case to compare the two and undermine the challenging defence environment, there is a strong case to explore avenues for far greater availability and serviceability of high value capital assets such as airborne platforms. Seeking enhanced numbers whilst current assets lie idle is not the answer.

There is a need to explore options to centralise major repair and overhaul of airborne platforms across the military requirements and letting industry take on the role, thus freeing higher cost uniformed personnel for operational tasks. This can easily encompass the commercial aviation sector to enhance economies of scale and optimum exploitation of high value plant and machinery.

Following from the above rationalisation, identifying optimum training, logistics and support models that derive benefits from this integrated approach and the resultant economies of scale is important. Outsourcing to the private sector, where possible, would need exploring for greater cost effectiveness.

Defence Production Units & DRDO

A parallel step is to apply the same management scrutiny to DRDO, HAL, ADA and the six DRDO Labs that deal with aeronautics. Serious thought needs to be given to part privatisation of HAL, ADA and some laboratories of DRDO to free them to adopt competitive management and market driven cultures. Only select divisions identified for advanced research in future technologies and vehicles must remain with the MoD. Their research will be driven by the IAF and other service requirements and they must be generously funded and be accountable for results.

The Private Sector

In order to be able to provide cohesive and integrated partnership to the military and civil aviation sectors, it is desirable for the private sector to formally organise itself into a, say, 'Society of Aerospace Manufacturers' which would be the single point of contact with the government agencies. As we approach this nascent stage of large-scale involvement of the private



sector in aeronautics, especially defence aeronautics, the sector will initially need to be supported institutionally and financially to enable it to reach a stage of becoming an equal partner. In the final analysis it is their international partnerships that will enable flow of technology, open export markets and benefit Indian aeronautics and the economy.

The choice to be a potential international player

Indian Aeronautics is today at a crossroads. There is great potential within the entire aeronautics community, both public and private, to analyse its areas of strength, weaknesses and more importantly its huge potential using all scientific and management tools at their command such that, within the span of the next decade, the Indian aeronautical industry can take its rightful place in the international market. We need to be convinced of this potential, have the will to bite the bullet, evolve a strategy, plan to implement it and have the grit to stay the course. If we lay the correct foundation, Indian aeronautics will prevail.

The Preamble to the *National Aeronautics Policy 2004*, proposed by the Aeronautical Society of India quotes Dr Abdul Kalam, the then President of AeSI thus: "Aviation is one of the most significant technological influences of modern time and

empowers the nation with strength for international partnership. It is a major tool for economic development and has significant role in national security and international relations." This stands as true today as when it was said a wasted decade ago. Regrettably time is now running out for Indian aeronautics.

It was in pursuance of this vision that the Aeronautical Society of India had submitted a blueprint of a National Aeronautics Policy in 2004. The conclusions of the background paper to the proposal are worth recapitulating as they highlight the core of our aeronautics dilemma:

- For growth in Indian aeronautics we need an enabling environment, strong incentives, improved infrastructure, enhanced flexibility and adequate human resources. At present an integrated approach is lacking. Individual organisations and departments involved across the spectrum of aeronautics are like isolated silos.
- There is an urgent need for a strategic form of intervention in designing, developing and marketing successful aeronautical products, as objectives are linked across sectors and over time. Progress in a strategic field like aeronautics is impeded when institutions are locked in wasteful adversarial relationships. We need to evolve from 'How can I stop you?' to 'How can I help you?'
- Technology will be the greatest driver for growth in this century. In aeronautics, India has the opportunity to leverage technology to generate economic growth and development. For this to happen, we need to transform our latent capability to deliver complex, aeronautical products to the world by improving productivity and moving up to the intellectual end of the chainfrom mere 'know-how' to 'knowwhy.' The National Aeronautics Policy encapsulates this vision.

At this crossroads, therefore, national policy makers have to now take a call. We can choose the untraveled and bold path of implementing the National Aeronautics Policy driven by a Department of Aeronautics supported by a National Aeronautics Commission, which amongst other things, will look at the issues discussed above towards the mission of bringing Indian aeronautics into the international market within the span of one decade. Alternatively we can choose the well-trodden path of maintaining status quo and see national aeronautics wither away with attendant national security, industrial and economic consequences.

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Corridors of Power: Parliament House in New Delhi.
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Depleting Air Assets

Air Marshal Anil Chopra (retd) urges that it is Time For Full Throttle⁷

MiG-21s are being forced to solider on well past scheduled retirement dates (photo: Simon Watson)

The Indian public was indeed shaken by the explosive letter sent from former Army Chief General VK Singh to the Prime Minister in April 2011 lamenting the Indian Army's"lack of preparedness". Recent media edits have questioned whether India lost those critical 'good economy' years to bridge the increasing gap in its defence provess. Two months before retiring in December 2013, then Indian Air force chief, NAK Browne, had expressed serious concern at the declining fighter aircraft strength. Of the 'authorised' 42 fighter squadrons, the IAF is down to 34 and to prevent further downslide, the planned phase out of six squadrons of older MiG-21 variants (M and bis) has already been delayed to end-2016.

The MiG-21 Bison fleet will per force have to continue till 2025 (or eight years beyond that planned) with depleting availability of spares. The DRDO-designed, HAL-built Tejas Light Combat Aircraft (LCA) is nearly three decades in the making and still faces serious technical shortcomings. The delays in formalising the medium multi role combat aircraft (MMRCA) contract would

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now push this acquisition into the 13th Plan, starting March 2017. Thus forced to stretch old aircraft to remain in service as a 'deterrence through numbers',this will naturally have safety implications. China has nearly three times the number of combat aircraft than has India. IAF's quantitative 'edge' over its arch rival, the PAF, is at alltime low ratio of 1.54:1. And numbers are further depleting.

India is located in arguably the most threatened region of the world. West Asia has been a boiling pot and in turmoil for years. Pakistan remains in turbulence and there are unknown challenges in Afghanistan. Emerging China is already flexing its armed muscles to dominate the region. Threatened India has little choice but to maintain the world's third largest armed forces but build up of military strength has not kept pace with such increasing threats. Lack of indigenous capability have forced imports of military hardware, and India has the ignominy of being the biggest importer of weaponry in the world.

'Over democratic' India takes years to identify, select and induct weapon systems. Complex procedures, bureaucratic redtape, delay-forced technical specification changes, political interference and, sometimes, 'unauthorised' commission payments cause continuous delays. 'Scandals' in the Bofors howitzer procurement for the Indian Army, the Barak naval missile case, and more recently, the AgustaWestland VVIP helicopters for the Indian Air Force are obvious cases in point. In spite of the Defence Procurement Procedure (DPP) being repeatedly refined, there are considerable gaps that need plugging. Direct government-to-government purchases, as used to happen in the Soviet era and the recent Foreign Military Sale (FMS) route with the USA, are perhaps the fastest, least controversial and overall in best interests of the country. The result of delays in weapon procurements, is forced extension of obsolete weapons and platforms, reduced operational efficiency, flight safety risks-all leading to compromises in national security.

Future Battlespace

Aerospace is the future battlespace and both the land and maritime forces are investing heavily in air power. The Indian Army will soon have more helicopters than does the IAF and has also been considering fixedwing ground attack aircraft. The Indian



C-130J-30 'special mission' aircraft in action disgorging paratroopers (photo: Angad Singh)

Likely IAF combat aircraft squadrons in 2020

| Туре | Number of Squadrons |
|-------------|---------------------|
| MiG-21Bison | 04 |
| Su-30MKI | 12 |
| Mirage 2000 | 03 |
| MiG 29 | 03 |
| Jaguar | 04 |
| MiG-27 | 02 |
| MMRCA | 04 |
| LCA | 03 |
| FGFA | 01 |
| Total | 36 |

Navy's second aircraft carrier Vikramaditya and the recently acquired new generation Boeing P-8Is and MiG-29s are illustrative of the trend. Notwithstanding the IAF's recent induction of special operations Lockheed C-130J-30 (unfortunately one was recently lost) heavy-lift Boeing C-17 Globemaster IIIs, and significant number of Su-30MKIs, many other procurements have for long been held up. At the current pace, it may take 20 years to reach the authorised 42combat squadrons. The IAF's, asymmetric advantage over Pakistan has considerably reduced and China is pulling way ahead with two fifth generation fighter types under development, with large numbers of fourth generation J-10s and Su-30 clones steadily replacing the obsolescent types.

I feel a three pronged approach is the only way forward : accelerate purchase

of already selected systems, improve indigenous capability with a clear long term strategy and- most importantly – improve service ability, thus availability, of existing aircraft and weapon systems.

Fast Track Procurements

After a grueling selection process and having tested the 'best of the best' fighters in the world, the IAF down-selected the French Dassault Rafale'omni role' fighter, which would bring a new dimension to India's national security, incorporating advanced technologies to efficiently perform multiple missions. It has new weaponry and high mission accomplishment rates, stealth features and electronic warfare suites to improve its survivability. Extended mission range will give the IAF dominance, projecting power through 'air-sovereignty' missions till the Indian Ocean littorals to match India's



ageing and in need of replacement (photo: Angad Singh)

trainer, an RFI for 106 additional PC-7s has recently been issued. The 45 year - old second stage Kiran basic jet trainer is already over worked and HAL's Intermediate Jet Trainer (IJT) is far from getting cleared for induction. There is a perennial shortage of 600 pilots whose alleviation is hinged on the availability of suitable training aircraft.

The future of aviation is actually in the unmanned area, this hitherto low priority area requires particular attention. More Unmanned Aircraft Systems (UAS) need to be procured and indigenous development accelerated. Effective surface-to-air missiles and ground-based radars are most critical for air defence. While the indigenous 25 km-range Akash missile is to replace older Soviet-era Pechoras, India was to co-develop with Israel a variant of the Barak as the IAF's Medium Range SAM (MR-SAM) having an



global standing and aspirations. Benefits of transfer of modern technology including AESA radar would mean imbibing extensive technical knowledge. The aircraft was slated to enter service with the IAF three years after contract signing but delays will have obvious repercussions.

Then, the case for attack helicopters. Procured over 20 years ago, Mi-25 and Mi-35 attack helicopters, in spite of upgrades, are overdue for replacement. The Boeing AH-64 D Apache Longbow has already been selected, which with its nose-mounted day and night sensor suite for target acquisition, is heavily armed. Its four hard points typically carry a mixture of AGM-114 Hellfire missiles and Hydra 70 rocket pods. Each wingtip can carry an AIM-92 Stinger twin missile pack. Induction of the 22 AH-64 Apaches needs to be hastened. Similarly, the Boeing CH-47 Chinook was selected to replace the IAF's ageing Russian Mi-26 heavy lift helicopter fleet. The CH-47 would mainly be employed for troop movement, artillery emplacement and battlefield resupply. The Chinook has had considerable combat exposure, earlier variants having been in Vietnam and more recently, in operations in Iraq and Afghanistan.

Another area that requires urgent attention is flying training. Having been 'stranded' by the sudden grounding of HPT-32s,the consequential fast tracked acquisition of Pilatus PC-7 Mk IIs for the basic stage has made a difference. Since HAL has not been able to progress on development of a viable indigenous basic effective range of 70 kilometres. Induction of another four Israeli Aerostat radar systems is pending, even as DRDO's own aerostats are still far away in the horizon, while indigenous Rohini and Reporter groundbased radars must be inducted in numbers: mountain radars are crucial for the northern borders.

The current force of three Phalcon AWACS would soon increase to five while DRDO completes development of its indigenous EMB-145-based AEW&C aircraft. However, several additional AWACS are required for a two-front conflict. The indigenous Ballistic Missile Defence (BMD) system based on the Swordfish radar derived from the Israeli Green Pine radar, combined with Advanced Air Defence (AAD) missiles is still eight-ten years away.

A Task Force 'approach' to Defence R&D

In spite of the sprawling Defence Research and Development Organisation and Indianorigin scientists proving themselves with NASA, there is little to show as far as indigenous 'final service use' products are concerned. No country parts with highend strategic technologies, and therefore one will have to 'beg, borrow or steal', an approach mastered by China. Transfer of Technology contracts has never been easy to implement. If India can have a world class space programme and a viable nuclear weapon inventory, then creating indigenous aircraft-development capability should not have been so very difficult and it is time to get our act together! There is need to create an independent task force, free from bureaucratic control. Delays in the LCA programme has been a major cause of the IAF's dwindling combat aircraft strength. India may have great scientists but most have been poor project managers. There is a need to induct professional programme management skills at the highest level to head defence labs and PSUs.





Absorb ToT via Offsets

The much more self-confident China has been far more open in taking foreign help in defence R&D and production while many third-world countries have very successfully leveraged offsets provisions to gain access to advanced technologies. The 50 percent offset clause in the MMRCA programme for instance, could mean nearly \$10 billion worth of work for Indian companies. HAL would be the direct beneficiary,but a question continuously asked is, whether HAL is able to absorb such massive offset amounts within short time frames? As HAL would be building most of the MMRCA, would it be able to maintain the production quality standards? Private Indian industry too has been salivating on the side lines waiting for their share of the MMRCA 'pie'.

In May 2001, the Indian Government 'opened' the defence industry for up to 100 percent (private sector) participation and

up to 26 percent Foreign Direct Investment (FDI), however, both subject to licensing. A higher percentage (up to 49%) of FDI could be cleared by Cabinet Committee on Security (CCS)in 'special cases'. Some of the major private-sector companies today are Tata Advanced Systems Limited (TAS), Larsen and Toubro, Kirloskar Brothers, Mahindra Defence Systems, Reliance, Ashok Leyland and a few others. Indian industrial strengths are well acknowledged, and surely can take on a range of activity from small component manufacture to electronics, software, heavy engineering, sheet metal work, high quality milling, etc. It is about time that MoD stops being indifferent and 'wields the stick' to synergise activities of DRDO, HAL and allied industry. There has to be far more pragmatic defence budget management with clear non-divertible separate amounts earmarked for capital acquisitions.



Technology is absorbed not only through acquisitions but also via major upgrade programmes such as the fleetwide MiG-29 enhancement currently underway (photo: Angad Singh)

Recover Low System Serviceability

The IAF's aircraft fleet serviceability has been hovering between 50 to 70 percent. Counting sub-systems unserviceability, effectively half the present inventory is operationally unavailable. 'Militarycontrolled' Pakistan on the other hand prides itself in maintaining high system service abilities (some 85%) and considers this as a force multiplier vis-à-vis India. A large number of imported systems also mean long supply chains. The IAF's experience with the Russian-origin fleet indicates a lead time of up to 18 months for spares and repairs and these are, operationally and financially, unaffordable. As is obvious, a 900 combat aircraft force with 50 percent serviceability effectively leaves only 450 aircraft for operations. Every 5 percent improvement in serviceability could actually add over two squadrons to the available force. The serviceability can actually be increased by spending a fraction of the investment required for new purchases. In some of the IAF's western-origin fleets, the foreign OEM ensures prompt turnarounds and swift supply of spares. These methods should be replicated across all aircraft types and the life cycle cost calculations become mandatory on all procurements.

Most armament and munitions have finite storage as also operational life. This invariably is around ten years but can be extended after some involved, and thus costly, checks. Replacements and procurements have to be scientifically anticipated, obsolescence catered for. Quantities stocked have to match





Mirage 2000 serviceability in the IAF has been generally better than older Soviet/Russian-origin types (photo: Angad Singh)

operational plans. An aircraft costing Rs400 crore with just five days of armament reserve is actually good for nothing, and this very vital aspect in procurement needs far greater attention.

India's commanders have to cater for three war scenarios : specific wars with China or Pakistan, or a collusive Sino-Pak two-front war, this third possibility being accepted even by the nation's ostrich-like political establishment. In such contingency, major inter-theatre shift of forces will be required which has its own consequences. For such an eventuality, a minimum of 45-50 combat squadrons are required by the IAF, but it may take some three decades to reach this force level.

Security of the nation needs the highest priority and continuous attention. The IAF's combat aircraft numbers have relentlessly dwindled over the past few decades. The writing is on the wall. Much more should have been done much earlier, and it is time to go full throttle –now !



Through the looking glass*



Reproduced are excerpts of the speech given by Air Chief Marshal NAK Browne, then CAS, on occasion of Initial Operational Clearance-2 of the LCA Mk.I, on 20 December 2013 at Bangalore—without comment.

"Having come a long way since the finalisation of Air Staff Requirements (ASR) in 1985, Tejas has completed an arduous journey through a complex and challenging design and development process and has achieved the required certification standards for airworthiness, manoeuvrability and air to air as well as air to ground weaponisation. It is indeed a proud day for the nation and particularly for the IAF; since the grant of IOC acknowledges the capabilities of this aircraft and paves the way for induction of LCA Mk.I into operational service.

"The design and development process for LCA Tejas has added tremendous learning value for our scientific fraternity as well as HAL and has created a vast

repository of knowledge during the design refinement and realignment over these years. These must not be lost as we move onto other programmes. Through the initial phases, the Technology Demonstrator as well as the Limited Series Production (LSP) aircraft proved the fundamental strength of this platform while incorporating multiple enhancements for retaining LCA's efficacy in the fast paced and technology driven operational environment. Today, the LCA project has seen successful integration of a state-of-the-art avionics suite in a well defined glass cockpit configuration. The aircraft uses significant composite structures and incorporates robust control laws for the digital fly-by-wire system. Successful integration of various types of air to air and

air to ground weapons have added much needed firepower to this fighter. All of these core technologies and design features have made Tejas a truly modern fighter aircraft inspite of being the smallest and lightest in its class.

"Personally, I greatly value my association with the Tejas programme since 2007; when I took over as the Deputy Chief of Air Staff. And as I prepare to hang up the uniform at this month-end, I would have gone home as a sad person if the LCA IOC had not been achieved. So my sincere thanks to the LCA team for making this wish come true ...

"While the nation celebrates grant of IOC to Tejas, we cannot rest on these laurels since our work is well 'cut out' for the days ahead. With the series production of 20 IOC aircraft being an immediate goal, ADA with its associated design partners and HAL have to continue steering the project steadily towards achievement of FOC standards by Dec 2014, as directed by Hon'ble RM. It is also imperative that we establish a robust spare support supply chain for maintaining the fleet in the coming years. With the integration of new BVR missiles, integral guns and air to air refuelling capability, LCA will acquire increased potency and enhanced operational efficiency as envisaged at the FOC level.

"As the programme gathers pace, we must remember that the final goal for all of us is not just the LCA Mk I, but the LCA Mk.II. While our air warriors are fully geared up to induct and operationalise the two Mark I squadrons, IAF keenly looks forward to induction of four squadrons of LCA Mk.II as the final version in its projected force structure. This calls for a focussed and coherent approach by all stake holders with determined efforts to overcome all existing

weak areas in design and management. The two primary design drivers already identified by us are the critical GE 414 engine integration for enhanced thrust along with perhaps a better intake design and improved maintainability of the platform. With better HMI functionality and a more efficient avionic system architecture, these design improvements promise to add to LCA's operational capabilities, as envisioned in the ASR. Under pinning these design improvements is the immediate need to adopt efficient management structures. Although we have the most qualified and capable designers and engineers as part of our team, reluctance to change impedes our ability to make mid course corrections and steer the project away from obvious pitfalls. The way ahead calls for close monitoring and monthly reviews at the highest levels. I therefore urge all agencies to be ready to 'bite the bullet' and never hesitate in making tough decisions as they work towards the final induction of LCA Mk.II into IAF."

* Through the Looking-Glass, and What Alice Found There (1871) is a novel by Lewis Carroll (Charles Lutwidge Dodgson), the sequel to Alice's Adventures in Wonderland (1865). The themes and settings of Through the Looking-Glass make it a kind of mirror image of Wonderland: the first book begins outdoors, in the warm month of May, uses frequent changes in size as a plot device, and draws on the imagery of playing cards; the second opens indoors on a snowy, wintry night exactly six months later, on 4 November, uses frequent changes in time and spatial directions as a plot device, and draws on the imagery of chess. In it, there are many mirror themes, including opposites, time running backwards, and so on.

The book's title was referenced in Oliver Stone's 1991 film, JFK, when Jim Garrison says to his staff (paraphrasing), "We're through the looking glass. Here white is black and black is white."



The Tejas LCA :

Life Beyond the IOC

ith much fanfare, mutual back-thumping and generous distribution of accolades, the documents for completion of the IOC Phase II (sic) were handed over to the Defence Minister on 20 December 2013. The fact that the first series production Tejas LCA aircraft will be available to the Indian Air Force only in the second half of 2014, was obfuscated in the euphoria of this 'Historical Event'. No questions were asked and no answers were given !

There is a long way ahead beyond the IOC and the Full Operational Clearance (FOC) is far from being achieved. At the ceremony for the IOC, wild promises were made by ADA, HAL and others. These were accepted at face value by the Defence Minister and reiterated by the CAS, with the 'promise' that "FOC will be completed by December 2014". Most of those who uttered these fictional promises would not be in their respective chairs for long, and have therefore cleverly absolved themselves of any accountability, which has been the single most damaging lacuna in the 30-year saga of the Tejas light combat aircraft.

And what does the FOC entail ?

At the very outset it is necessary to understand what FOC means and the quantum of work involved, which reveals that the time required to do this will be a minimum of two years - or more. The daunting tasks ahead include midair refuelling, high AoA clearance, envelope expansion to 8 g, ventral tank integration, BVR integration, additional weapons including those on tandem carriage, gun integration, auto pilot higher modes and others.

Full Operational Clearance entails clearance of the aircraft to the full extent of its planned -and agreed upon - performance envelope for uninhibited operation in service. Apart from envelope clearance, feedback from the user, who will be flying the IOC aircraft for any improvements, or modifications, is an integral and mandatory part of the FOC. The earliest that the IAF can expect to form a 'Handling Flight' with a minimum of four aircraft (six would be far more useful) is by end-2015. The FOC would by then either have been completed or be very close to completion, thus defeating the very purpose of practical feedback. If one is to wait for this, then the obvious repercussion would be yet another delay in induction of the Tejas LCA into the IAF.



A brief overview orientation of the Herculean task that lies ahead to achieve FOC is reviewed hereunder :

- Clearance for air-to-air refueling
- High Angle of Attack clearance to 28 degrees
- Envelope expansion to +8 g
- Ventral fuel tank integration and testing of drop tanks designed for supersonic flight
- BVR missile integration
- 23 mm gun integration
- Other weapons, including those for tandem carriage
- Enhancing auto pilot modes
- Improvements driven by user feedback (unlikely or scanty)
- Miscellaneous improvements such as tougher wind screen, quartz radome
- Addressing pending issues on the Mk. I which will be inherited by a Mk.II

More importantly, there surely will be considerable inputs from the IAF when they commence service flying and suitable changes in the avionics / attack modes may be required to be incorporated. Maintenance improvements would surely also have to be undertaken.

However, the most critical path for achieving FOC is air-to-air refueling and initial plans were to have an aircraft modified by June 2014, with two years expected for certification. Next is the gun. The possible effects of vibrations are being underestimated. Generation of CCTL is also complicated. Then there are drop-in replacements like a tougher wind shield, quartz radome etc which will stretch timelines for testing and certification. Supersonic DTs are new and will surely stretch timelines. Rest of FOC activity including the final envelope and 'carefree maneuvering' should be subsumed within the above.

Every one of these issues have their own challenges and it is pertinent to mention a few critical ones which are more complex and time consuming.

O Air to air refueling is a major challenge that involves not only pilot skill, but also depends on ease of flying the aircraft accurately and more so, stability of the platform itself. In an unstable platform like the Tejas, the control laws will have to be meticulously derived and painstakingly tested. It has yet to be resolved whether a separate control law will have to be evoked for this phase of flight or will gains of the existing law be frozen, so as not to disturb the status quo ?

- A similar situation will exist when vibrations from the gun are measured. Since the bullets will be released at supersonic speeds, within the envelope cleared, the disturbance may require a modification to the existing control law or a freezing of the gains itself. These will require study only when the vibration levels are actually measured, all these being time consuming.
- Each factor to be tested and cleared requires an immense amount of work, with flight testing, freezing of modifications planned and finally clearances from CEMILAC. To visualise that all these can be completed within one year is sheer fantasy.

Present Status

After the IOC celebrations petered out, some LCA sorties were flown, those too on the Naval variant (two-seater) till the second week of January 2014. Additional sorties on the single seater Tejas have also been flown, but for the purpose of completing certain unfinished business, albeit interrupted by the flying required for displays on the day of celebration.

None have in fact been flown towards the FOC. The Flight Test Requirements for this phase are still to be generated, which involves detailed discussions between the Designers and the Certification Agency. Once they both reach a mutually acceptable agreement, these results would then be transferred to the National Flight Test Centre, where Test Pilots and the Flight Test Engineers would deliberate over them and convert this requirement into test points. The test points in turn are converted into the number of flight test sorties to be flown, keeping a reasonable margin for repeat sorties. This exercise to decide upon the number of flights was expected to be completed by the first quarter of 2014.

It is now left to the discretion of informed observers of the Tejas LCA programme to take an educated guess as to when the flight testing will commence and the FOC achieved... or are we fated to once again witness a new phenomena in December 2014, known as Phase I of the FOC !

The first series production Tejas (SP-1) is in HAL's final assembly hangar, the fuselage structure is ready and being equipped, to be ready by mid 2014. Perhaps three more series production LCA's will be delivered by March 2015 when the IAF's Handling Flight can be formed, although user evaluation may begin earlier.

That the IAF is not exactly complaining about this additional delay by HAL can only be construed as a measure of the IAF's eagerness to actually induct the Tejas !

Air Commodore (retd) Parvez Khokhar

[The author has over 45 years experience in military and civil aviation including instructional and experimental test flying. He was also Project Director (Test Flight) of the LCA programme]



If Wishes Were 'Planes !

obsolescent F-5s still in service with half a dozen air arms including those of Switzerland, Chile, Bahrain, Botswana, Brazil and others.

There was of course a caveat : the concerned industry would 'adopt' the LCA as existing, then work with would not only have achieved FOC but be on verge of entering IAF service with full confidence of the service, even as its natural export potential was being vigorously exploited, paving the way for the follow on Advanced Medium Combat Aircraft.

So what happened?

The proposal remained just at that. Not even a cursory attempt to study it, let alone

explore this once-in-a lifetime opportunity.

RIP.

awn at a Luftwaffe airbase in northern Germany. The whine of jet engines makes way to a muffled roar as jet fighters take off in pairs to disappear beyond the horizon, returning to land an hour later and taxi to their dispersal and switch off. So what's new? The aircraft ! These are Indian-origin twin-seat Tejas being employed as lead-in fighter trainers by the German Air Force before air crew are posted to frontline fighter squadrons.

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Fantasy ? Not if the Government of India had followed up on the unique proposal made to it in January 2012 when such an opportunity presented itself. In fact, the Germans were seriously interested in the LCA twin-seat version, themselves, with some dozen aircraft to be imported and then adapted for the role. Had this taken place, the LCA could have even been a serious contender for meeting the United States Air Force T-X programme to replace the current T-38 Talon lead-in fighter trainer, with a potential sale of several hundred such aircraft.

That European Aerospace Company promoting this opportunity also forecast that the Tejas LCA could well become the selected type to replace hundreds of ADA and HAL to clear pending technical and tactical issues, productionise the aircraft to meet Indian Air Force requirements with simultaneous efforts to export it. The proposed partnership would have created an industrial foundation, producing the LCA (under HAL leadership) providing effective life time support for the Indian Air Force while establishing a credible global marketing, sales and product support network.

It was assumed that the combined Indian (Air Force and Navy) requirements would be some 300 aircraft and even with a production rate of 18 aircraft a year, HAL would take some 17 years to fulfill this need. The proposal was to vitalise the production rate to 4 aircraft a month (48 a year) of which a good proportion would be for the export market.

The joint team of specialists would work on the engineering and production processes, determine the critical path, including outsourcing of production and assembly of major components, to ramp up production with final assembly, outfitting and test flying by HAL, while the partner would concentrate on management of outsourced parts and exports.

It was opined that only the Chinese JF-17 fighter aircraft had lower acquisition costs, but the higher price of the LCA would be more than compensated with lower operating costs (engine, carbon content and weight) and built in low observability.

Had this offer, with 'no strings attached' been taken forward, the Tejas LCA by now

Opportunities lost

n his policy statement made in mid-2011, then Defence Minister AK Antony churned out the mantra that India could only realise its full potential in Defence R&D by achieving far greater synergy between DRDO, Defence PSUs, Ordnance Factories, Private Sector Industry, Academia and Research-based Institutions in the country. Further, he wanted the private sector to play a bigger role in collaboration with the public sector, there being a lot of space for the private and the public sector to coexist, in various spheres including infrastructure development, logistics, training, simulation and exports... becoming an important constituent of the global Defence supply chain. Joint ventures and technical collaborations would help the Indian Defence industry to strive for greater excellence in Defence R&D, design, engineering and manufacturing.

Antony stressed that participants of India's defence industry must strive to provide long term thrust to boost defence exports. Considering that India imported defence items worth over Rs 25,765 crore in the past three years, its exports in the sector was a pathetic Rs 740 crore only. The exported items included arms and ammunition, aircraft components, communication equipment, radars, night vision devices and harbour tugs.

It was thus a most opportune time in 2012 for the Indian Government to take advantage of proposals being made to energise its industry—and where better a start than the Light Combat Aircraft programme?



The HF-24 Marut Mk.1

In the beginning – actually in the mid-50's – were laid the plans for developing an indigenous combat aircraft and considering that the Indian industry had at the time neither the knowledge nor infrastructure to embark on this most ambitious of undertakings, it was an astonishingly bold and brave decision. The resultant HF-24 Marut fighter bomber, designed and developed under leadership of the legendary German designer Kurt Tank, became a reality in less than a decade. The Marut's Godfather arguably was India's first Prime Minister Jawahar Lal Nehru who had the vision – and authority – to achieve this scientific and industrial breakthrough, notwithstanding formidable obstacles.

The HF-24 came about to meet the Indian Air Force's Air Staff Requirement (ASR) for an advanced combat aircraft which would be employed for both the high altitude interception as well as low level ground attack duties. The requirement further specified that it should be possible to develop an advanced jet trainer, night fighter and `navalised' version of the basic aircraft.

In pursuance of the national objective of attaining self reliance in the design and production of combat aircraft, it was directed that this aircraft be developed within the country. Hindustan Aircraft Limited, as the present Bangalore Division of Hindustan Aeronautics Limited (HAL) was then known, was given the task of preparing itself for the project. The fledgling HAL was at the time engaged in the manufacture of the first generation





Vampire under British licence and its own design experience was limited to the modest HT-2 primary trainer. Accepting the Indian Prime Minister's invitation, the famed German aircraft designer Dr Kurt Tank, accompanied by his deputy, Herr Mittelhuber, arrived in Bangalore in August 1956 to establish and head the design team which would give the ASR shape and substance.

The HF-24 Marut was developed, manufactured and first flown in March

1961, leading to its entering service with the Indian Air Force in 1967. However, the HF-24 remained perennially underpowered as the original engine was not developed further in the UK and HAL had to accept the much less powerful Orpheus 703 with which the type was barely supersonic.

Still, HAL went ahead and produced a total of 147 Maruts of all variants including twin-seat operational type trainers. The HF-24 Marut served with three front line squadrons of the Indian Air Force in war and peace till it was (prematurely) retired from service in 1983.

After several decades of infructuous attempts to re-engine the HF-24 and feasibility studies carried out on derivative aircraft (the HF-73 proposal, marrying the essential HF-24 airframe with a pair of RB-199 turbofans and modern avionics and systems), all proposals were dropped and the Indian Air Force was cleared to import large numbers of combat aircraft from abroad (the Anglo-French Jaguar and French Mirage 2000, apart from MiG-23/27 and MiG-29 from the then Soviet Union).



HF-24 Maruts at HAL Bangalore Complex: when the type was 'retired', at least 50 aircraft had several years of operational life left.



Sadly, all expertise gained in the design and development of the HF-24 was thereafter 'lost' as HAL were 'denied' new projects for over a decade till the Light Combat Aircraft programme was conceived and accepted by the Government of India (GoI) in 1983. So as to 'fast track' and make up for time lost, the GoI cleared establishment of an independent 'society' to fund, monitor and manage the programme with the designation 'Light Combat Aircraft'. The Aeronautical Development Agency (ADA) thus came into being but as the seminal paper by Dr SR Valluri, ADA's first Director General and former head of the National Aeronautical Laboratories (NAL), later recorded, this 'last opportunity' was soon dogged by parochial interests which actually countered the national objectives of having an indigenous combat aircraft programme which would give "Indian designers and scientific community a tangible programme; Indian aerospace industry considerable work in country and the Indian Air Force an aircraft affordable in large numbers." The last objective was really the priority as nearly 500 MiG-21 variants in service had to be replaced in time bound manner.

Unfortunately, priorities for the LCA programme and its very raison d'etre soon enough got muddled with the result that the customer for whom the fighter was being developed in the very first place was 'forgotten' and the scientists and technologists got their hands full with developing everything de novo, even many low technology items which were readily available off the shelf. The LCA became a virtual learning exercise even as a frustrated Indian Air Force continued to phase out squadron after squadron of obsolescent aircraft, reducing its force levels from 42 squadrons in 1999 to 32 in 2013. Starkly put, the LCA which should have gone into IAF squadron service in 1999, will only achieve full operational clearance (FOC) in 2015-16 by when the IAF will have phased out another 8 squadrons of MiG-21/MiG-27s while forcedly extending service life of the six MiG-21Bison squadrons by five years, or well beyond their anticipated life.

Thus, caught in a no-win situation, and with continued attrition of the IAF's combat strength, the Government of India cleared the acquisition of 126 (plus 63) medium multi role combat aircraft (MMRCA) in 2004 but the process of evaluation and selection took another 7 years and a formal contract has still not taken place in 2014. The MMRCA had to be an optimum solution, both as an affordable 4th generation multi role fighter to complement the heavy Sukhoi Su-30MKIs being received in large numbers by the IAF as also a hedge against continued delays on the LCA programme. Interestingly, over the period, what was to be essentially a medium MRCA (under 20 tonnes) evolved into becoming a heavy MRCA, with down selection of the Eurofighter Typhoon and Dassault Rafale.

Fate of the LCA being inducted in large numbers is obviously dependent on its meeting the original Air Staff Requirement (which the Mk.I will not) and ensuring that industrial production is to the highest standards, with interoperability as a critical factor. As for pricing, present cost estimates have HAL calculating LCA's unit cost at US \$48 million which is some 50% higher than the IAF had budgeted for.



Production Blues

Cranking out the numbers



Tejas LCAs in formation flypast at an Aero India Show.

AL's Bangalore Complex consists of several Divisions, the oldest being the Aircraft Division which traces its foundations to the 1940s but one which has been expanded and modernised with introduction of new programmes since the 1980s. The current production programme is confined to the BAE Systems Hawk Advanced Jet Trainer, 99 of which are being manufactured under licence, which have followed the 100+ Jaguar

strike fighters built under licence from the erstwhile British Aerospace. These are now being upgraded to Darin III standards at the neighbouring Overhaul Division.

With new programmes expected in the near future, HAL's management have been planning to establish new facilities for the medium multi role combat aircraft (MMRCA). Following flyaway receipt of 18 aircraft, HAL would be licenced to produce another 108 at the Bangalore Complex, probably followed by another 63 aircraft once the contracts have been finalised. The total programme cost is estimated at an enormous US \$ 30 billion but HAL will be comfortable to rely (as always) on the licensor to provide all methodology and technical support for processing and producing the aircraft to the quality and interoperability standards extant.

In fact, apart from the HF-24 Marut and HJT-16 Kiran programmes, HAL's



Bangalore Complex has for decades remained comfortably reliant on the licensing partner to provide such 'handholding'. The experience with HALdesigned and built aircraft has been poor and the prime customer, the Indian Air Force, have expressed their dissatisfaction with HAL at the highest Government levels. Grounding of the HPT-32 basic trainer and the IAF repeatedly rejecting its indigenous successor, the yet to fly HTT- 40, has resulted in fast track import of the Pilatus PC-7 Mk.II which has only further disillusioned a sceptical (and essentially only) customer.

The long-term future of the Tejas LCA in Indian Air Force service could thus well be dictated by confidence in HAL's ability to produce this fighter to the highest industry standards extant - on time and at cost. The Indian Air Force only reluctantly agreed to a first tranche of 20 LCA Mk.Is (16 single seaters and 4 twin-seat trainers), first series production of which aircraft should be delivered to the Aircraft and Systems Testing Establishment in Bangalore in the second half 2014 for operational trials before handing over to the nominated squadron in 2015-16 (long designated being No.45 Squadron, which phased out its MiG-21bis in such anticipation during 2002).

The LCA's Final Operational Clearance (FOC) will practically follow only four years later by when the IAF could have received new generation fighter from Europe even as some 270 Sukhoi Su-30MKIs would have gone into service. It is argued that if the LCA is already considered obsolescent today, what about ten years from now ?

Meanwhile, a second tranche of 20 LCA Mk.Is was 'politically cleared' but again to a very reluctant customer. Compounding the uncertainties felt by the IAF on the 'usefulness' of the LCA in its Long Term Planning, is the time and cost aspect. HAL currently estimate that they can realistically produce only 8 LCAs per annum, at a cost of Rs 204 crore (\$ 48 million) each of which is more than that of the 4+ generation Gripen which has been on offer to the IAF to meet the MMRCA role.

When series production of the LCA begins, HAL will have built 15 LCAs : 2 technology demonstrators, 4 prototype vehicles and 8 limited series production aircraft, plus one Naval LCA all virtually 'hand built' ! HAL's production planning and execution has been hampered owing to inadequate or incorrect assembly tooling, perhaps also owing to delayed delivery of manufactured parts from outsourced vendors. The standard kit marshalling procedures are not being followed resulting in severe hold ups.

The LCA structure is primarily of composites, 90% by surface and 45 % by weight. The delta wing configuration, with no tailplanes or foreplanes, features a single vertical fin, of advanced composite material which has been the responsibility of National Aerospace Laboratories (NAL) at Bangalore. Again, indicative of HAL's nonreadiness is the fact that even after this essentially R&D Laboratory has delivered the first sets of (hand built) wings, NAL have been requested to continue producing the composite wings for the 20 series LCAs as well, for which NAL are certainly not equipped.

Development of the LCA Mk.II is still a fair way away, with the selected F.414 engine reportedly requiring considerable re-design of the fuselage. This in turn would add weight to the already over-weight Mk.I, thus negating the very reason for a higher thrust engine. Increased thrust is also critical for practical development of the ship-borne LCA Navy as also the planned 'Advanced Medium Combat Aircraft' (AMCA) which is to be a 'Fifth Generation Stealth Fighter' to follow the LCA.

In the IAF's planning, a successful LCA Mk.II could be inducted in quantity (some 100 aircraft) which adding to the 40 Mk.Is already ordered, would make a total of 140 Tejas delivered to the IAF during the 12th and 13th Five-Year Plan periods (2012-2022). Or, just about the same number as HF-24s built.

The LCA by numbers - and first flights

- **TD-1** (KH2001) 4 Jan 2001
- **TD-2** (KH2002) 6 June 2002
- **PV-1** (KH2003) 25 November 2003
- **PV-2** (KH2004) 1 December 2005
- **PV-3** (KH2005) 1 December 2006.
- PV-5 (KH-T2009) 26 November 2009
- LSP-1 (KH2011) 25 April 2007
- **LSP-2** (KH2012) 16 June 2008
- LSP-3 (KH 2013) 23 April 2010
- **LSP-4** (KH2014) 2 June 2010
- LSP-5 (KH2015) 19 November 2010.
- **NP-1** 27 April 2012.
- **LSP-6** yet to fly
- **LSP-7** (KH2017) 9 March 2012.
- **LSP-8** (KH 2018) March 2013.
- SP-1 to SP-40 flights yet to commence

The IAF : an increasingly 'heavy' fighter force ?

n the wake of India's frontier war with China half a century ago, the Government of India cleared expansion and modernisation of the Indian Air Force, alongwith the Army and Navy, so as to ensure credible defence into the future. The Indian Air Force, then equipped with transonic fighters and bombers (British Hunters and Canberras, French Mystere IVAs) was to be expanded into a 45-squadron combat force with supersonic interceptors and fighter-bombers to gradually replace the existing types. Owing to political-economic reasons, the Soviet MiG-21 fighter was eventually selected as mainstay of the IAF, supplemented by the Su-7 for the ground attack role.

Over the next 5-7 years, the Indian Air Force was expanded, not only its combat and transport aircraft inventory but also the infrastructure for training, maintenance and radar/communication systems. By 1970, the IAF had reached a level of 35 combat squadrons, including some obsolescent types, but with increasing indigenous production (mostly MiG-21 variants), the IAF was expanded to a peak of 42 combat squadrons (including with British Jaguars, French Mirage 2000s and Russian MiG-29s) by the late 1980s. However, over 60% of the combat strength was composed of MiG-21s and MiG-23/27s, these Sovietorigin types being manufactured under licence by HAL.

In the long term re-equipment planning of the Indian Air Force, steady replacement of the some 20 squadrons of MiG-21s was assuming increased importance and to address this, the Government sanctioned the indigenous design, development and production of what came to be known as the Light Combat Aircraft (LCA) programme which was to eventually replace the MiG-21/23/27s in operational service with the IAF. The LCA programme was launched in the mid-1980s with the hope that this aircraft would meet the air staff requirement (ASR) formulated by the IAF. It was planned (and hoped) that after development flight testing, series production would begin at HAL in the late-1990s leading to induction of the first LCA squadron in 1999 even as earlier model MiG-21s were being phased out.

In the event, the LCA's development got stretched by more than a decade and it was not till January 2001 that the prototype even made its first flight. The programme thereafter continued at slow pace and initial operational clearance (IOC) was only accorded in late 2013 with final operational clearance (FOC) expected two years later in late 2015 (*see separate article in this issue*).

The impact of this delay has already resulted in some serious consequences for the IAF : the remaining 15 or so squadrons of MiG-21 variants and MiG-27s which should all have been phased out by 2016-17 will perforce continue in frontline service for several more years. Meanwhile, the IAF will have received 12 squadrons (or so) of Sukhoi Su-30MKIs, both imported and licence built by HAL in India, but these are of a far heavier class and consequently far more expensive to acquire and operate. Legacy types such as the Jaguar, Mirage 2000 and MiG-29, of which there are a total of 12 squadrons, are being currently upgraded and will continue in service till 2030.

Consequently, by 2017-18 the Indian Air Force will have reduced combat force of

less than 30 squadrons, nearly half of them composed of the Su-30MKI. The MMRCA and LCA were each to equip six squadrons but the former is yet to be contracted for and the latter (in its Mk.I variant), will not meet the bill, while the future of its Mk.II successor is doubtful indeed.

Looking into the future (14th Plan onwards), the IAF will start phasing out the legacy types with plans to replace these with the indigenous advanced medium combat aircraft (AMCA). At the same time, the Russian T.50 FGFA was expected to follow the Su-30MKI production line at Nasik. Selection of a relatively 'heavy' MMRCA, with an initial six squadrons supplemented by another three, meant that the IAF's fighter inventory was becoming disproportionately 'heavy', so that by 2032, the IAF's centennial year, the order of battle could well look like :

| Su-30MKI | = | 12 squadrons |
|----------|---|--------------|
| MMRCA | = | 9 squadrons |
| FGFA | = | 6 squadrons |
| AMCA | = | 8 squadrons |
| Totaling | = | 35 squadrons |

The case for additional equally competent but much more affordable multirole fighters, has never been more logical.

Cover Story

The Gripen forges ahead in 'Super' mode

This diminutive Scandinavian fighter has been transformed into becoming one of the world's most potent and cost effective combat aircraft. Here's how Saab's success story is playing out.

At a time of diminishing defence budgets and out-of-control development and manufacturing costs across the globe, one major defence programme visibly stands out. Beginning as a light fighter, produced in comparatively low numbers for a captive, domestic customer, this project has quietly built momentum since it began in the early 1980s and now stands as arguably the most promising export-oriented combat aircraft programme in the world – the Saab JAS 39 Gripen.

Focused studies for the replacement of Sweden's Saab Draken and Viggen fighters began in 1979, with the goal of producing a high-performance but affordable fighter that would accomplish the roles of both preceding aircraft types. This led to the 'JAS' designation - Jakt (fighter), Attack (air-tosurface strike) and Spaning (reconnaissance) – essentially indicating a multirole aircraft. Saab proposed a number of designs to fulfil the Swedish requirement, and the Swedish Defence Materiel Administration (Försvarets Materielverk - FMV) eventually settled on a lightweight single-seat, single-engine aircraft that incorporated the latest in aerodynamically unstable design and fly-bywire technology. To keep costs and risks low, a General Electric F404-400 afterburning turbofan, modified and produced by Volvo Aero as the Volvo RM12, was selected, continuing a successful trend of adapting and manufacturing Western powerplants for use in Swedish fighters.

Progress on the Gripen was quite rapid by standards of the day, at least among European fighter development programmes. It first flew in December 1988, and the first production aircraft was delivered to the FMV less than five years later, in mid-1993. Designed to be highly upgradable right from the outset, in terms of both hardware and software, development work on an upgraded export-oriented model of the Gripen began shortly after the first Gripen A/B deliveries had commenced. Thus, Sweden's cumulative Gripen orders totalling 204 aircraft were fulfilled in three batches. The first of these batches was delivered under a fixed price contract but interestingly, Saab and the Swedish FMV agreed on a 'target price' concept for the second batch, with any deviations from the target price (whether a cost overrun or a cost

saving) would be borne by both Saab and the FMV. The third batch was an order for 64 upgraded Gripens (50 Gripen C and 14 Gripen D), fulfilled in 2008. This last batch was delivered at a cost that was 10 per cent *less* than the agreed-upon price, continuing to set the tone for what was becoming a highly efficient programme.

In 2007, on the tail of the third Swedish production batch, as well as the recognition that the global fighter market was entering a phase of fiercely competitive growth, a two-seat Gripen NG demonstrator was ordered. This aircraft incorporated the most comprehensive upgrades for the type - a new engine to facilitate increased kinetic performance and higher payload, greater range as a result of increased internal fuel capacity and a raft of avionics updates, including an AESA radar. The aircraft, numbered '39-7,' served essentially as a development testbed for the technologies that would ultimately be fielded in the definitive 21st century variant of the Gripen - the JAS 39 Gripen E/F family (also known as the Gripen NG - for new generation). The Gripen Demo aircraft first flew in May 2008, and has clocked hundreds of test flights since then as part of a concerted campaign to minimise development time (and therefore programme cost).

Electronic wizardry is the future

If the Gripen E/F programme had a *mantra* it would probably be 'high capability at low cost.' This central theme means that Gripen NG development has been ruthlessly focused on producing an aircraft that is at

least as good as its peers but at a fraction of the cost – both to acquire as well as to operate. The GE F414 engine, for instance, is well known for the level of reliability it marries to high performance, and was a natural choice for a new powerplant. Sensor development was conducted by Saab as well as avionics partners, such as Selex ES, leveraging a mix of innovative solutions and proven technologies to ensure that costs remained controlled. Airframe changes were minimised to essential areas so as to reduce certification issues and limit the changes that would be required to production tooling and processes. All this results in an aircraft that looks much the same – and feels much the same – but brings a quantum leap in performance and combat ability to the type *[see box item]*.

The performance and payload improvements embodied in the Gripen E/F have been largely validated already – for instance, the Gripen demo aircraft showed off its supercruise ability as far back as 2009. However, the real 'heart' of the programme, so to speak, is in the new electronics. Saab has rightly recognised sensor performance as one of the key areas in future air combat and a significant portion of the Gripen E/F project is dedicated to the fielding of vastly



Gripen NG demo aircraft pictured with 'swing role' payload – LGBs, Meteor BVRAAMs, IRIS-T SRAAMs and underwing drop tanks.



enhanced sensors compared not only to the preceding Gripen variants, but also to contemporary fighters worldwide.

To this end, Saab and its partners have invested heavily in cutting edge technologies such as gallium nitride (GaN) for sensors such as AESA radars and electronic warfare (EW) systems. While the Selex AESA uses proven gallium arsenide (GaAs) technology for its transmit/receive modules, the Gripen E/F will feature a GaN-based EW suite that provides tremendous situational awareness. It is significant that both Selex and Saab have thrown their weight behind the new GaN technology, which is expected to enable more powerful and yet more reliable AESA antennae as compared to those that use existing GaAs modules. Additionally, with the impending proliferation of lowobservable combat aircraft around the world, Saab has incorporated a Selex Skyward-G infrared search and track (IRST) sensor and a new IFF (identification friendor-foe) system.

The Selex Raven ES-05 AESA radar is the first production AESA in the world to be mounted on a rotating swashplate, vastly improving the radar's field of view. Most AESA arrays are fixed and therefore have a fixed field of view, which is often considered quite narrow when compared to older mechanically-steered radar arrays. However, the range and instantaneous scanning ability of AESA radar sets make them tremendously attractive in modern day combat. Combining the two - AESA performance and mechanical steering gives the ES-05 a much larger field of view than comparable arrays, estimated at over 100°. The new three-antenna IFF system provides low-latency coverage across the radar's entire field of view and matches its maximum range, providing reliable information on targets within detection range of the Gripen.

The IRST employs a long-wave focal plane array sensor, also called a 'staring array,' with three fields of view. In longrange search mode, the system effectively

behaves as an infrared telescope and in wide-angle mode it provides a nightvision image that can be projected on the head-up display (HUD). Being a passive sensor, IRST systems can only provide reliable azimuth and elevation data but the Skyward-G is also able to provide rudimentary range information via 'kinetic ranging,' wherein the aircraft performs a weaving manoeuvre and range to target is determined by the change in azimuth or elevation angles. Additionally, the IRSTs on two (or more) aircraft can triangulate range to target by sharing tracking information over their datalinks. Skyward-G is based on the Selex PIRATE system used on the Eurofighter Typhoon, but by virtue of being newer, has seen more development on both the hardware and software fronts, allowing for better and more discriminate performance.

When all the new detection hardware, that is the ES-05 radar, the Skyward-G IRST unit and the IFF system are employed together, the situational awareness provided to the pilot, including against low-observable targets, is remarkable. Crucially, however, the IRST adds a level of self-defence to engagements with low-RCS targets that other fighters equipped only with AESA radars would lack. As a passive sensor, it emits no signals and is therefore undetectable as it scans for targets. Once a target is acquired, the IRST can continue to track it whilst undetected, waiting until the last possible moment to switch to an active (but detectable) sensor such as the AESA radar. With 'lock on after launch' (LOAL) technology, the IRST can even be used to guide a missile toward the target without using any active sensors at all, letting the missile seeker conduct terminal guidance to the target. Not only does this make the Gripen E/F an effective 'counter-stealth' platform at a very affordable cost, it also makes the platform much more survivable against any opposing fighter – stealth or otherwise.

This level of sensor fusion and situational awareness makes for much more effective performance in various situations. For example, in the air defence role, a Gripen E can operate safely even among civilian traffic – the IFF system would handle information from friendly/commercial aircraft, freeing up the other sensors (radar, IRST) to track or engage unidentified or hostile craft.

As of going to press, the Gripen Demo aircraft (39-7) has flown with both the ES-05 AESA radar and its swashplate mounting and the production-standard Skyward-G IRST system. The IFF system

What makes the Gripen E/F so 'Super' ?

While externally similar to earlier Gripens, the Gripen E is a revolutionary development of the JAS 39 platform, and different from the Gripen C in a number of ways.

- 1 The new F414G-39E engine produces around 98 kN of thrust in afterburner, over 20 per cent higher than the F404-based Volvo RM12 in the Gripen C. This has necessitated larger air intakes.
- 1 The Gripen E has a higher maximum takeoff weight (16.5 tonnes versus 14 tonnes), translating to higher payload.
- 1 The undercarriage has been redesigned with the mainwheels relocated to bulges under the wing roots, freeing up room inside the fuselage for an incredible 40% increase in internal fuel capacity as well as increasing space under the airframe for additional hardpoints.
- 1 The Gripen E incorporates a new self-protection and EW suite, using the latest gallium nitride (GaN) antenna technology.
- 1 A new AESA radar from Selex is one of the primary distinguishing features of the new Gripen. The antenna

is mounted on a rotating swashplate that widens the field of view of the planar array. Additionally, the Gripen E also incorporates a new IFF (identification friend-or-foe) system.

1 An infrared search and track (IRST) sensor, also from Selex, is one of the most visible changes to the Gripen E, and allows the aircraft to track even low-RCS targets at beyond-visual ranges.



is expected to be delivered for testing sometime in 2014.

In addition to the on-board EW and self-defence suite, the Gripen will also be the first aircraft to offer the new 'BriteCloud' off-board active decov from Selex. BriteCloud is a self-contained Digital RF Memory (DRFM) jammer for fighters, and was launched by Selex on 6 November 2013. Saab will offer BriteCloud as an electronic warfare option on all versions of Gripen.

BriteCloud is specifically aimed at defeating modern tracking systems, both ground-based and air-based. Its DRFM technology is able to defeat even contemporary chaff discrimination techniques, effectively creating a convincing false target that allows a wide range of threat systems to be countered.

As an off-board device, BriteCloud avoids the 'home-on-jam' vulnerabilities of on-board devices where the source of jamming itself acts as a beacon for hostile sensors and munitions to target. Additionally, since BriteCloud does all processing and transmitting inside the unit rather than on the platform, it is able to put a significant distance between itself and the fighter after launch. This minimises the risk of incoming missiles detonating in close proximity to the platform, further increasing the efficacy of the system.

Testing and production

As noted briefly before, the Gripen NG programme began with a low-cost technology demonstrator based on the Gripen D, modified to incorporate many of the proposed Gripen E/F changes, from the new engine to redesigned landing gear, and of course, an all-new cockpit layout (implemented for the rear seat only). This risk-reduction platform, aircraft 39-7, has logged some 300 flights (totalling around 260 hours) since it first flew in 2008, validating the vital systems and airframe attributes of the new project whilst Saab drummed up sales interest in the type around the world.

A model-based design technique is yielding enormous cost savings through the development and testing of this programme. Advances in design and manufacturing are being pursued parallel to the flight testing of 39-7, allowing Saab to project significant increases in productivity and savings once the aircraft finally enters production. As



Aircraft 39-7 pictured inside the Saab facility at Linköping in 2012 (photo: Angad Singh)

an example, the demonstrator activity conducted by aircraft 39-7 has been performed for just 40% of its initial projected cost.

Now, however, Saab has begun the next stage and started fuselage assembly work on the first of three 'new-build' Gripen E test aircraft at its Linköping facility, and has also revealed more detailed design information on the type. The three upcoming test aircraft will be constructed from the ground up as Gripen Es, as opposed to modifying an existing structure as in the case of 39-7. In effect, this makes them the first 'proper' prototypes for the programme. It is interesting to note that while Sweden's order for 60 Gripen E specifies that the aircraft must be remanufactured from existing Gripen C stocks in service with the Swedish Air Force, the Gripen E actually does not retain much of the older airframe, only reusing parts of the fuel and air systems,

the ejection seat, windshield, canopy and outer elevons.

The first new flight test aircraft will be numbered '39-8' and will be followed by a static test airframe numbered '39-83.' The latter is also already under assembly at Linköping. The first components that will be used in the construction of second test aircraft '39-9' are also under production, and that aircraft will enter assembly late this year or early in 2015.

First flight of the lead test aircraft (39-8) is scheduled for next year, with the singleseater to be used primarily for airframe and flight control system testing. 39-9 is then expected to take to the air in the first half of 2016, and will support tactical systems development. Any changes identified from these two flight test aircraft will be embodied in the last airframe, '39-10,' which will join the programme in 2017, virtually in production configuration. Once again, cost



The Czech Gripen fleet completed 10,000 flight hours in 2010, and the aircraft are contracted to remain on lease until 2029.

savings are realised by conducting a large portion of modelling in software. Where the Gripen C/D programme required some 4,000 test sorties to conclude development, the Gripen E/F is expected to require less than 1,200 sorties spread across all three test aircraft, a tremendous feat in both engineering and cost-control.

The first production example should follow close behind 39-10, with Saab targeting military type certification in early 2018. This should result in the commencement of deliveries of new-build aircraft in the 2018-2019 period.

Production is arguably the linchpin of any military manufacturing programme all the technology in the world is of no use if it is delayed, unreliable or unaffordable. This reality is not lost on Saab, which has long had to balance Sweden's fierce neutrality with its aspirations toward selfreliance in defence. Indeed, the Swedish defence industry as a whole has long been regarded as the model for frugal, wellengineered solutions. It is not surprising therefore, although certainly impressive, that the Gripen E/F programme will cost less than the Gripen C/D programme, with savings across the board from development to production as well as operational costs. The Gripen E/F represents that rarest of capability improvements, one that does not come with a correspondingly hefty price tag.

Extensive pre-production design work has resulted in a reduced parts count for the new airframe, and shorter component manufacturing times, making each aircraft less complex and quicker to put together, resulting in large savings on the factory floor. Saab estimates a 50 per cent increase in productivity as compared to the later stages (that is full rate production) of the Gripen C.

The firm has not only drawn on its experience from the Gripen A/B to C/D conversion programme, but also on industry best practices acquired from manufacturing work done for Airbus and Boeing commercial products. Saab's involvement in the multinational nEUROn unmanned combat air system (UCAV) project has also paid dividends.

The worldwide Gripen fleet, presently operating in six countries (Czech Republic, Hungary, South Africa, Sweden, Thailand and the UK) has logged over 203,000 flight hours, and according to Saab, has



Three Gripen C and one Gripen D conduct a formation display over their 'home city' of Linköping, Sweden (photo: Angad Singh)

demonstrated extraordinary reliability and low operating costs. The Swedish Air Force, for instance, currently estimates the total cost per flying hour (CPFH) of the type as being around \$7,560. With the changes to production processes applied for the Gripen E/F programme, it is not unreasonable to expect the new variant to enter service with comparable hourly operating costs. In any case, a 2012 study by Jane's noted that the Gripen boasted the lowest operating costs of any contemporary Western fighter. Jane's metrics had the Gripen outmatching even the F-16 Block 40/50, an aircraft that is often used as a benchmark for comparing operational costs across various fighters.

Saab forecasts that it will sell between 300 and 400 new Gripens across the globe over the next 20 years. Given the promising trajectory of the programme so far, that target actually seems modest !

Angad Singh

History in motion !

Sixty-six years separate these Saab aircraft types, from the J-29 to the JAS-39. The Saab 29 Tunnan first flew in 1948, and the JAS 39 Gripen remains in production today. Saab AB is among the oldest aircraft manufacturers in existence and has operated continuously in the aerospace arena for 77 years.





Saab's Terminal Challenge: the RBS 70NG

ith crucial gaps in India's Ground Based Air Defence Systems still lying unplugged, Saab has offered the RBS 70 NG to fulfil the Army's requirement for a VSHORAD (Very Short Range Air Defence) System. The RBS 70 entered service in 1977 as the Mk.1, while the current production model is the Mk.2. Over the years, the system has undergone constant upgrades and improvements. In 2003, the Bolide missile was introduced. Bolide is a further development of the Mk.2 with increased

speed and manoeuvrability ensured by the new sustainer rocket motor. Comprising surveillance radar and firing units, the RBS 70 possesses automatic tracking capabilities and ability to detect multiple targets, both day and night. The system, in its various evolving versions, is operational with the Swedish armed forces and has also been exported to 18 countries worldwide.

The RBS 70 NG comprises a 'beam rider' Bolide missile in the launch container, a tripod-firing stand and an optical sight, operable by one, and portable by three persons. The system can be vehicle-mounted by rapid moving units and remotely controlled. The laser beam detector is mounted at the back of the missile since the RBS 70 NG rides a laser signal being beamed from its own launch station, rather than being guided from the front towards the reflected signal from a laser-designated target. The output from the laser beam detectors in the tail of the gyroscopically (implementing fibre-optics) stabilised missile are used by an onboard processor to generate the steering and course correction signals that manipulate the missile control fins. It can be operated independently in stand-alone mode or can be configured with several firing units (up to nine) linked with truck-mounted Saab Microwave Systems Giraffe surveillance radar to form an anti-aircraft battery protecting an area of 175-square kilometres.

The missile is equipped with a solid propellant booster motor developed by Bofors and a solid propellant sustainer motor produced by BAE Systems Land and Armaments, and Imperial Metal Industries. When the operator fires the missile, the booster motor is ignited inside the launch tube and the missile is accelerated out of the tube. The control surfaces and the four fins deploy as the missile leaves the tube. The sustainer motor ignites shortly after the missile has travelled a safe distance from the launch position, subsequently jettisoning the booster. Presently, daynight capability is ensured by a close loop cooled Clip-On Night Device (COND) operating in the 8-micron to 12-micron infrared band (with a 12x8 degrees field of view), produced by FLIR Systems. A hostile target is located visually by the missile operator or detected by the Giraffe surveillance radar. On acquiring a target, the installed Raytheon Cossor IFF80 Identification Friend or Foe (IFF) system tracks the target in tandem with the operator. Detection of a friendly immediately halts the launch sequence, while in the case of a hostile intrusion, the operator aims the missile towards the target and fires, constantly beaming a laser guidance beam at the target until the moment of impact. The RBS 70 NG sight enhances the capability of the Bolide missile by reducing the tracking noise through the implementation of an auto-tracker function. Less noise will result in even higher manoeuvrability and higher kill-probability than in the present RBS 70 system against small targets at maximum range.

Since the missile has no seeker head at the front of the missile and the laser beam riding system resides in the tail, it is highly jam resistant, being unaffected by hostile countermeasures and clutter. The 1.1-kg fragmented shaped charge warhead is fitted with a Saab Bofors adaptable laser proximity fuse and an impact fuse, allowing the weapon to take on a range of adversaries, from fixed and rotary wing aircraft to small, dark targets such as cruise missiles and UAVs to armoured targets like attack helicopters and armoured personnel carriers (APC).

The RBS 70 NG has a maximum speed of more than Mach 2, an effective intercept range from 250m to 8km, with altitude coverage in excess of 5,000m. It is capable of operating in complex combat fields such as urban environments and is well equipped for all climates, including tropical, desert and arctic conditions. With more than 1,600 RBS 70 launch and guidance units and more than 17,000 missiles sold, the user's experience with the system is that it is "easy to use, quick to reload and fast to deploy."

Sayan Majumdar









Saab to acquire Swedish arm of ThyssenKrupp Marine Systems

ThyssenKrupp Industrial Solutions AG, a subsidiary of ThyssenKrupp AG, and Saab AB have signed a non-binding Memorandum of Understanding (MoU) concerning the sale of the Swedish shipyard ThyssenKrupp Marine Systems AB (formerly named Kockums) to Saab. During the negotiations phase, both parties agreed that the integrity and the operating ability of ThyssenKrupp Marine Systems AB must be safeguarded, and that the transaction will be subject to regulatory approval. The negotiations between Saab AB and ThyssenKrupp Marine Systems AB are at an early stage but the MoU is in line with Saab's ambition to expand its activities in the naval area and meets the needs of Sweden for an industrial solution regarding design, production and maintenance of submarines and warships.

Saab and Pilatus to augment ties

On 28 March, in Bern, Switzerland, Saab CEO and President Håkan Buskhe and Lennart Sindahl, Executive Vice President and Head of Aeronautics at Saab, signed an MoU on future cooperation with Pilatus. The MoU, also signed by Pilatus CEO Markus Bucher and Jim Roche, Vice-President Government Aviation and Deputy CEO, places Saab and Pilatus on course to cooperate in the replacement of the Swedish Air Force's current trainer aircraft, the Saab Sk60, should Sweden decide to replace the fleet. Sk60 is the designation given by the Swedish Air Force for the Saab 105 trainer aircraft, which Saab developed in the early 1960s for the Air Force.

Saab Gripen NG demonstrator's first flight with IRST system

On 31 March 2014, the Saab Gripen NG demonstrator aircraft (tail number '39-7') made its first test flight with a production standard IRST (Infra-Red Search and Track) sensor, in line with the type's development schedule. The test flight verified IRST functions and their integration with the Gripen NG demonstrator aircraft. The IRST system being integrated is the Selex ES Skyward-G and present plans call for another eight test flights in a preliminary development campaign during April 2014. Prior to the test flight in March, 39-7 had flown with a non-functional IRST-shaped fairing to prove the basic aerodynamic installation for the hardware.

Production of Gripen E begins

Saab has begun construction of the first Gripen E (single-seat) test aircraft of the next generation Gripen E/F programme. Work on this aircraft (to be numbered '39-8') began in March, with fuselage assembly currently underway at Saab's facility in Linköping, Ostergotland. If construction and development proceed as planned, 39-8 should take to the air for the first time in the second half of 2015. The first single-seat test aircraft will be followed by a static test aircraft, designated 39-83, and then another flight test aircraft, numbered 39-9, which is scheduled to fly some time in 2016. The accelerated development of the new generation Gripen means that the flight test campaign for the NG programme will involve fewer aircraft and less time than similar projects around the world, helping ensure that Saab meets the 2018 target for delivery of aircraft to export customers.

Saab Skeldar UAS to integrate with MISC ISR system

The latest addition to Skeldar's ISRcapabilities is its integration with another Saab product, the Multi-Sensor Intelligence Cell (MSIC), which is a flexible ground-based system developed to collect, process, analyse and report intelligence data; providing the functional layers between airborne surveillance units and C4I systems. MSIC has been used for Swedish UAV operations in Afghanistan and for Gripen reconnaissance missions over Libya, during Operation Unified Protector in 2011. The Skeldar and MSIC integration work was undertaken in-house by Saab's development teams. The full combined functionality was verified during a series of Skeldar flights at Saab's Motala test facility in February 2014.



Saab extends surface radar portfolio

Saab has extended its surface radar portfolio, with the introduction of five all-new complementary Giraffe radars for land and sea, which not only augments the current product range but also takes the Giraffe firmly into the long-range air surveillance domain and puts an entirely new capability onto the market.

These highly-regarded surface radars, including the renowned Giraffe AMB and Arthur radars, have been improved through the addition of new technologies and designs. Alongside, Saab is now producing new active electronically scanned array (AESA) radar variants for land and sea.

Saab's surface-based radar family for land and sea includes Giraffe 1X and Sea Giraffe 1X; short-range radars fitted with an X-band AESA, offering a comprehensive set of 3D functions with impressive performance and flexibility; Giraffe 4A and Sea Giraffe 4A; medium- to long-range radars, combining air surveillance, air defence, sense and warn and weapon locating capabilities in a single, low-footprint S-band AESA-based unit; Giraffe 8A; a long-range S-band AESA radar, including anti-ballistic missile capability, that pushes performance and functionality to a new level; Giraffe AMB and Sea Giraffe AMB: Saab's existing shortto medium-range surveillance radar and command and control system for groundbased air defence.

Czech extension on Gripen lease

The Czech Government has approved an extension of the lease on 14 Saab JAS 39C/D Gripen fighters operated by the Czech Air Force. The lease will be extended by a further 12 years, with an option on a further two. The Czech Air Force took delivery of ten JAS 39Cs and two twin-seat JAS 39Ds in 2005 on a ten-year lease through to October 2015. They are operated by 211 Taktica Letka (Tactical Squadron) from 21 Základny Taktického Letectva (21st Tactical Air Base) at Cáslav. Under the new agreement, Saab will incorporate enhanced ground attack capabilities in the aircraft, equip them with night-vision goggle-compatible cockpits and install a low-altitude anti-collision system. Over the duration of the contract, Sweden will also train 25 Czech pilots and 90 ground maintenance personnel.





An 'open source' assessment by Professor Prodyut Das

f reports that the Kaveri turbofan engine has reached 90% of its full I military power are true, this represents a considerable achievement for the engineers concerned ! It also indicates that no foreign collaboration is required to complete this project. The above numerator is unfortunately tarnished by the denominator of several decades of development with no engine flight clearance and a realistic date of completion being uncertain. Development of jet engines pre-supposes certain facilities as sine quo non: test rigs for combustion chamber development; test rigs for testing the compressor spools together at rated conditions; test rigs for testing the turbine blading for cooling, thermal and mechanical loads simultaneously and finally a flight test bed to test the engine in the air. The last listed item is still not available in-country

and there are reasons to believe that the first three were not available at the time of taking up the project-and may not in fact be satisfactorily available even now.

Readers will recall the time when Egypt, bravely developing the E300 engine under guidance of the redoubtable Ferdinand Brandner, having much poorer traditions and resources than India, had a flying test bed which was a modified An-12, as long back as in 1964.

The lack of these basic test rigs and their exploitation would have had significant effect on the Kaveri programme. The present "problems" with the engine – lack of performance, unreliability and overweight–can be traced directly to the lack of the required test rigs and indicates that there was a lacuna in top leadership. It was 'disconnected thinking' in 1987 to confidently state that the Kaveri would be 'flat rated'. The basic tools needed for the job were nowhere. The relatively low total running hours (< 2000hrs for the entire programme spread over about ten engines) means that the infantile 'measles and mumps' kind of problems have not yet been encountered. If the total engine hours are correct, it was surely premature to have air tested the engine in 2003 when it, quite expectedly, had failed. "As part of the learning process" is not an adequate explanation for this kind of repeated selfinduced "failure". This failure has delayed the project and should not have been done at that point of time. I recall a former Director when discussing the Kaveri pressure ratio, privately admitting "Yes. We did overreach ourselves." He was being modest! The fault, dear Brutus, is in our stars !


Going back in time, Pratt & Whitney (P&W) was not allowed to work on jet engines during the ongoing World War at a time when GE was well ahead. Immediately after, in 1945 itself, P&W established a Turbine Laboratory (WTL), naming this critical asset after their Chief Engineer Andrew Wilgoos (and not after Rentschler, their Founder & Chairman). WTL was fully integrated into P&W's mission "to be a prime player rivaling GE" and could tap into the skills and resources of P&W. In contrast, the Gas Turbine Research Establishment (GTRE) was set up in 1959 but was a completely different entity vis-a-vis HAL in terms of its aims, service conditions and critical parameters. Yet GTRE was dependant on HAL, so that even with the best of intentions, results were inevitable.

Still, the good news is that an engine which is giving 90% of its cold thrust cannot be all that bad! The engineers who can achieve this too cannot be bad either ! What has been lacking is 'leadership' over several generations of higher management. We will return to this point later. In fact, the Kaveri engine does not need any more technology. It needs much more care and analyses. Jet engines, though inherently simple, are extremely sensitive to detail as the following examples will illustrate :

"Point one millimetre" ('four thou' if you like) is the general unspecified tolerance in aerospace machinery. It is the average thickness of a human hair. If the gap between the rotating blades and the casing varies by this 'point one' millimetre in a Kaveri-sized engine, it means a difference in the turbine tip/casing flow area of about the size of a 20mm hole. Imagine the differences in flow if you are dealing with pressures of around 20 bars! If the clearance is of that order there will soon be very 'expensive sounds', with blades being shed and possibly an engine fire. The tip clearance is a decider for TBOs. The current technique is to remotely sense the tip clearance and heat or cool the casing locally to keep the clearance constant. No wonder the grudgingly respected Chinese engineers still manage to stir fry their new engines with some regularity! The same 'thickness' (or thinness, if you will) in the engine casing will vary weight of the engine by approximately 5-8 kg and an increase or decrease in engine length by about ten millimetres will affect engine weight by about 4 to 5 kgs because of casing and shaft weights. Of course a 0.1 mm variation in blade profile is unthinkable. I cite these figures to stress on the 'gearing' between cause and effect in jet engine development and the need to go over details, components and results with a fine comb - plus an engineering Sherlock Holmes by your side!

However creditable the performance of engineers in the design office, the present situation is a reflection on higher direction of the programme. There have been two major management issues. The first was to have undertaken the project without having the physical resources at hand. "Everything is always wanted yesterday"! It appears the then leaders (assuming they knew clearly what was involved) either wanted to "make someone happy" or wanted the project "at any cost". Honesty about the situation so disdained by the "clever" is an essential requirement and a mark of leadership. In 1962, Lt. Gen BM Kaul, by acceding to political pressure, created 'the Himalayan Blunder'. Nine years later Sam Manekshaw by stubbornly (but charmingly) refusing to move until he was ready, delivered Bangladesh !

Failure of knowledge

The second factor of failure in leadership is actually a failure of knowledge. There was perhaps lack of a holistic view inwhat the engine was supposed to do. "They" apparently wanted an engine "just like the F.404", rather than thinking more systemically about an adequate engine which would provide suitable power for the light combat aircraft. By these two fatal lacunae–one physical and the other mental–GTRE fell into the "mission impossible" trap.

Rebooting our mindset

Let us look at the above in some more detail. Modern Western military engines are, not surprisingly, strongly injected with technologies developed for competing in the civilian markets. It makes sense for the West to use these thoroughly proven technologies in their military programmes as it helps to amortise costs. An opposite corollary was the old Soviet Union where technology development was always led by military requirements and Soviet civil engines were consequently the dregs in terms of SFC and TBO. For a civilian engine, a TBO of 4000 hrs is 'essential'. The airliner flies fourteen hours per day. One cannot yank the engine off the pylon every 6 weeks in R-29B style entailing 550 hour TBO. Every gram of fuel saved per hour is of consequence given the massive number of hours flown per year. This requires engines having compression ratios of 20:1 to 30:1 with current developments reaching an incredible 70:1. One could go on in this direction but the drift is that before we follow someone's lead, we have to stop and think of our own task and the cloth that we have to tailor our coat.

So what are these?

★ Slash the engine's TBO to around 400-500 hours to begin with. Insist that the Air Force declare what their attrition rate is for single engine, close air support fighters. I know we lost about 30 Hunters out of 120 active in the six squadrons during the nine years between induction in 1957-58 to just before the 1965 war. Very few, if any,

of these fighters would have approached 1000 hours. It would be interesting to have a histogram of the number of engine hours of all the MiG -21s at the time of their write off. If this figure is pretty low, as I suspect it to be, there is no need to make a 2000 hour TBO or 4000hr technical life as an immediate target. A TBO of 250 hrs would at least last a couple of years on a fighter airframe. Reduction of TBO time will significantly reduce the development task without affecting the operational efficiency. The 'problem' of low TBOreplacing engines can be ameliorated by designing for easy installation and removal. In the MiG-15, two men could do this in one hour. Engines are more 'plumbed' today but that is where the challenge of good engineering comes in. Incidentally, an Indian engine built with Indian materials in Indian factories would be formidably competitive against all comers even with these low TBOs and TTLs.

★ Do we really need 20:1 CRs (compression ratio) given that the engine becomes heavier and more surge prone as we jack up the CR ? Higher CRs mean more stages and the compressor and combustor casings being open ended pressure vessels, mostly in heavy alloys add much to the weight. Remember that a 0.1 mm thicker casing will add 8 kg to the weight. We know the benefits of high compression ratios are subjected to diminishing returns. The Orpheus with a CR of 6:1 had a SFC of 1.03, the R-25 had a CR of 12:1 and had a SFC of 0.9 and an engine with 20:1 CR will have an SFC of around 0.8. This 'high compression ratio' led improvement in SFC does not pay in our typical low duration sorties. For an IAF standard fighter sortie, the weight of an engine plus fuel required (for the same level of technology in other areas) disfavours the high compression engine. Also because the compressor passage areas are fixed, the resistance to compressor flows at part throttle (where the engine will be spending most of its life, anyway) increases proneness to surging and will cause problems. Finally, remember that high CRs in themselves are a partial contributor to the SFC figures burners, combustor and turbine blade technology are the others.

- ★ Are we worrying too much about exhaust smoke and NOx? Western 'standards' are again derived from already existing and already proven and available low risk 'civilian' technology which we do not possess. A short combustor means a lighter engine because the shaft and casing becomes shorter. Shorter combustors will require focused research on getting the spray pattern 'tighter' in the spread of droplet size. How much work has been done in this area before we set our targets?
- ★ Western aircraft design philosophy has it that VG intakes do not make sense below Mach 1.3. Our designers follow the same track. This, I believe, is a 'frozen' thought from the 1960s and the days of electromechanical sensors and actuators. Given developments in sensor technology and computer controls, we should look at new variable geometry intake configurations to maximise pressure recovery. Even if we can save the equivalent of one or two stages on the compressor it would help in reducing the length of compressor : ergo a lighter engine !
- ✤ Also to be examined is the total thrust/ fuel flow requirement profile and optimise the engine's weight and fuel consumption in relation to the task. A typical LCA type engine will have the following profile : afterburner thrust approx 2 ¹/₂ - 3 minutes, full military 6 minutes, 60% thrust 20 minutes, 45% thrust 25 minutes, and flight idle about 5 minutes. These figures are illustrative but the idea is that we must reduce the total fuel burn/sortie rather than optimise for a rarely used 'best' figure. The intake, the engine and the afterburner together have to be seen as a system which will give optimum performance in the Mach 0.6-0.8 range at low level with all other conditions being seen as 'special' cases for the system.
- ★ A consequent question on the point made above is given that relatively small duration of operation of the max. Installed thrust, how much of the thrust should come from the engine and how much from the afterburner? The Tyumansky/Gavrilov R-25 of the MiG-21bis is an example of alternative approach. The dry thrust is 59kN, with afterburner it is 69kN but with an

emergency 'boosted' afterburner, it gives 97kN (as per Russian sources) which thrust wise would be ample even for the LCA. Use of the boosted afterburner reduces engine life at the rate of one hour per three minutes - but it works! Anyway as said before, a 'totally Indian engine' will definitely be less costly.

There are several more such issues but the point being made is that we have to determine the task not for an engine 'just like something else', as I suspect has been done but to move from mere 'information' to 'knowledge' and, hopefully, from 'knowledge' to 'wisdom' GTRE has hamstrung itself by trying a 'drop fit' replacement for the F404. The saner approach would have been to have an honest dialogue with ADA so that they would be prepared to 'rebore' (not, please, literally as one irate reader seemed to think), the LCA's airframe to accept the slightly different engine. We must therefore come to a state of mind where we first 'read the book and then throw it away' to chart our own course.

So what needs to be done ? First build the test rigs !

"If you have ten hours to chop a tree, spend nine sharpening your axe" ! Build up and 'sophisticate' the test rigs so that the key problems can be solved in detail. For example the test rigs for the turbine blade should not only be able to handle a mass flow of around 5kg/sec @ 1400°C for a cascade of four or five blades but also be able to simulate the creep loads on the blade whilst a separate air source will supply cooling air through the internal passages. Similarly for the compressor test rigs, it is necessary to have rigs powerful enough to test the two spools together irrespective of what may be the practice in other countries. A short combustion chamber will need research on droplet uniformity, spray pattern, burner types and configurations. Turbulence and uniformity of temperature at turbine entry are other areas to study. The test rigs help to break down the problem before synthesising the solution. These test rigs are the axes for the problem and in future we must emphasise the vitality of test rigs and their role in any project. Normally the evolution, design, fabrication, and operation of productive test rigs will require the same quality of ingenuity and good engineering as the engine itself.

The obvious thing to do

Perhaps there is a need to review the Jet engine programme as a 'National' programme rather than a DRDO one alone. No single organisation can complete the programme by itself. In the UK, Bristol Engines starting jet development from scratch but asked Lucas to focus on the critical fuel systems and combustion. Team work has to be enforced by getting GTRE back to what it really was established for and HAL directed to take over from where GTRE left off and bring it to some state of 'civil behaviour'. It is certainly possible that some of HAL's experienced and 'best' designers and fitters from Koraput and the Engine Division are transferred to lead the Kaveri programme. Unfortunately, whilst administratively such action is possible, this will not work in present circumstances. Internal priorities must change, the organisations concerned must become more creative. As matters stand, GTRE must find a way out from the difficulties it has created for itself !

What ails us ?

Over the decades our wise men have replaced in our engineering colleges, 'practice based' engineering with 'science based' engineering, even at the undergraduate level. Consequently the GTRE, as with other scientific research establishments in India, has unquestioningly adopted the rather pompous assumption that possession of an engineering degree confers the abilities of an engineer to the holder. The natural consequence of this assumption is that higher the degree, the more the 'qualification' of the person to take engineering decisions, never mind that one of the most esteemed and successful engineering leaders in the country, who has unfailingly delivered, Mr. E Sreedharan of Pamban Bridge and Delhi Metro fame, is a 'mere' B.E. The reality is that engineering is a practioner's art and the 'qualification' irrespective of its degree, is merely a licence to enter the area. Possibly, as in education, in the selection of 'leaders', possessions of qualifications have outweighed other parameters. The result is a lack of engineering leaders who enjoy being 'at the front'. I could cite several examples of the effect that lack of senior engineering leadership has on the 'frontline'- but some other time ! However I will give an 'unrelated' example. Rommel won his battles often with inferior forces, because he had much more direct knowledge of the tactical situation 'real time' and was personally judging the situation with his great experience and technical skills rather than relying on what some inexperienced Feldwebel thought of the situation. This undistorted, experienced, assessment of realties came from being right at the front when his opponents were at their headquarters, far from the action. How many 'top' scientists work side by side with the engine fitters? The administrative problem is that passionate engineers often tend to be enfants terrible of the organisation and are often sidelined as being 'not quite mature' or 'good but simple minded'! The net result of all this is that GTRE probably has excellent administrators (and they are also needed) but do not have excellent practical engineers who can calmly 'think things through' and yet have the authority to get things done.

There be hope yet...

Despite the dark clouds, the situation is ripe for rapid rectification which should enable us to have (without foreign collaboration), a flight cleared jet engine within a predictable and short time scale. Foreign collaboration, if available, may not hurt but I believe that the 'demand' for collaboration is a bureaucratic 'fail-safe' decision and no one can be blamed. It is this lack of 'the right stuff people who will work on the engine rather than rush back for dinner, is why we are where we are at present. Instead of commercial collaboration, what we can do is to get retired engine designers over as a teacher or a guru. The Chinese not only regularly had Hooker over as an honoured guest, they also had Ferdinand Brandner invited as a Professor at their top University. However, I do not think Brandner simply taught the prescribed course! The other reason for rejecting foreign collaboration on the Kaveri is the nature of the present requirement. The answer to the Kaveri's performnce problems cannot yet be more technology as there is no 'magic' in technology, but more care and thought and listening to what the engine is trying to convey - yes it certainly does ! Assuming that the basic design (barring, apparently the afterburner) was sound, what is needed are a hundred small improvements : improving the surface finish of the compressor casing bore or the blades, working on cleaning up flows near the roots, stressing the components down to closer margins, tightening technology processes and so on rather than introducing 'blisks' or 'shrouded blading' or SCBs which everyone seems to want. We put in certain technology to do a job. Why then is this not happening ? It is here that GTRE is, by its charter, subtly handicapped. Being a R&D establishment, it does not have those seasoned practiced people whose hands can 'read' the engine even with their eyes closed. A R&D organisation anywhere in the world will not have the skills which are common at the production unit.

Cutting your coat

Therefore we need to:

- ★ Enter into a dialogue with the customer about TBO, engine change procedures, TTL et al.
- ★ Back off from trying to build something "same as the GE F-XYZ". It is not necessary or even the best solution. The airframe wallahs should be ready to rebore their fuselage. Everyone does it all the time, even the Chinese and, by association, the Pakistanis.
- ★ Flog the engines on the test beds even if they are developing no more thrust than kerosene stoves. If 550 hrs TBO is the technical target, one would expect 5500 hours on a batch of ten engines anyway. That way at least the infantile mechanical problems are exposed and can be corrected.
- ★ Prioritise the acquisition of more than one flying test bed. Few know that Harry Folland's last design was a large test bed to test the 2000 hp class Bristol

engines that were planned in the 1940s. A large but simple multi-engine aircraft such as an enlarged Canberra using the AL31, would be a fantastic project for 'people building'.

If we were to do it again

For the future, the task must be bifurcated, GTRE's contribution being to provide experimental data and HAL's Engine Division doing all the hands-on mechanical design detail for which HAL is arguably by far and away better placed to do. Let me illustrate by one example: the Kaveri's accessories drive gear box. HAL's Helicopter Division has years of experience designing and making lightweight gear boxes for helicopters. For reasons possibly of 'unease with HAL', ADA gave the contract to CVRDE, a sister organisation but having no aerospace collaboration and no direct access to the technology. My bet is that HAL Helicopter Division would have given a better gearbox in shorter time simply because HAL's supply chains of know how, information, machinery and process technology and human resources were shorter than that of CVRDE. With every 'license manufacture' agreement comes a wealth of information on materials, processes, heat treatments, machining methods, testing methods and parameters, even how and where to mark the part number and how to store the part. Over the years, HAL has, even subconsciously, processed this 'know how' into 'know why'. For the CVRDE, it would be new territory.



The difference may or may not have been much but please follow the dictum 'look after the days and the years will look after themselves'. This is why RAE and its counter parts at AMES or Zhukovsky do not design jet engines or aircraft.

A future Indian engine programme

What are the areas where DRDO/GTRE are particularly well equipped to focus on and what will be necessary for India to develop its future engine programme?

- ★ Carbon fibre fan casings: TETs, engine efficiencies and thrust are in symbiosis. Given modern TETs, a pure jet is no longer efficient and some degree of bypass is inescapable. The fan shroud operating at relatively low pressures and temperatures is an ideal case for (carbon) composites. DRDOs appropriate unit should develop expertise on fabricating and proving fan shrouds of approximate 900mm dia. and capable of handling pressures of 2-5 bars.
- Short length combustors: excellence in combustion is a key to fuel efficiencies and light weights. GTRE must focus on a target of the shortest combustor length. Dual spray nozzles optimised for cruise and max thrust as used in modern civilian engines may be explored *if found imperative*.

Compressor aerofoils: the R-11 achieved a 9:1 compression ratio using just six stages with consequent savings in weight. Could this be 'the starting block' for a new development programme aimed at high pressure ratio rise per stage with stable operations?

- ★ Carbon fibre fans capable of sustaining bird hits.
- ★ Turbine cooling technology: GTRE must further improve its capability to simulate actual conditions faced by turbine blades.
- Production technology for precision cast 'ready to use' turbine blades.
- ★ Expansible thermal coatings to minimise 'heat losses' through compressor casings.
- ★ Technology for 'milling' combustor surfaces to very close limits.
- ★ Fan gearing systems : future engines will all be geared so that the fan drive turbine can run at its optimum speed. This will give us useful freedom in fan design.
- ★ Blisks: the centrifugal compressors, carved from an aluminum 'cheese', was

an early such form of Blisk. If HAL has the Goblin compressors process sheets, these could be the starting point for our 'Blisk' programme. Why not give HAL the contract?

It is tempting to suggest that actual bench testing should be done by a different and independent group. Honda used to test all their engines at a different and independent test site. This is merely good industrial practice and should be worth replicating here.

The flying test bed is of course an imperative. 'Outsourcing' this function is simply not on. Apart from the problem of logistics there is also the subtle question of security of the engine itself when abroad. Countries adopt or build their own special aircraft for acting as a flying test bed. It is just a pipedream that if a few airworthy C-119G airframes were available today, one could fantasise with the idea of an interim test bed for the Kaveri ! The Fairchild Packet was configurationally ideal for a test bed. Of course an 'enlarged' Canberra (see 'The Haft of the Spear' in an earlier Vayu issue) would be another option. These would be simple aeroplanes capable of being designed, built and maintained by simple people and, critically, would need a simple budget !

With such a list of activities to do, GTRE would be a busy and happy organisation. I am reminded of the fact that TsAGI 'discovered' that the tailed delta configuration was the best layout for the supersonic combat role and such was the quality and reliability of its findings that both Mikoyan and Sukhoi OKBs were not too proud to rely on TsAGI data for the MiG-21 and Su-9 aircraft plan forms. Perhaps those proud traditions of high quality fundamental research continues today - the similarity of aerodynamic layouts of the Su-27 and the MiG-29 is no coincidence.

The logical way

We must reaffirm that the logical house for development of real engines is HAL's Engine Division. The reason is clear : they are organised, experienced and their supply chains are shorter. What then should they do ? In my mind, they should engage in the development of three 'core' engines using not tomorrow's technology, not today's technology but yesterday's technology. By yesterday's technology I mean technology that has been in production at HAL

The Kaveri flight tested in Russia

The Kaveri engine, being developed by the Gas Turbine Research Establishment (GTRE) as part of the Defence Research and Development Organisation (DRDO), has been test flown on a Russian Ilyushin Il-76 aircraft as a flight test bed (FTB), to carry out a series of successful trials which totalled 20 flight hours. The Kaveri K9 engine replaced one of the four engines of the Il-76 and the tests carried out up to 12 kilometres altitude and maximum forward speed of Mach 0.7 under varied operating conditions. This Kaveri engine had already undergone ground tests before being sent to Russia for FTB trials and other simulated tests.

The first flight test of the Kaveri engine was in 2010 at the Gromov Flight Research Institute (GFRI), near Moscow in Russia. The engine was tested through the regime, from take-off to landing and flew for a period of over one hour up to at an altitude of 6 kilometres at a speed of 0.6 mach on its maiden flight. The engine control, engine performance and engine health during the flight were found to be "excellent". Following this, several tests were carried out for reliability, safety and airworthiness. According to the Indian MoD, nine prototypes of Kaveri engines and four prototypes of the Kaveri Core (Kabini) engines have been developed, and near 2000 hours of testing conducted on Kaveri and its core engines at ground and altitude conditions.

In January 2013, it was declared that the Kaveri would be considered for powering the ADA twin-engined Advanced Medium Combat Aircraft (AMCA), for which initial sanctions have been accorded by the MoD.

Earlier this year, the Indian Government admitted that there has been a ten-fold increase in cost of the indigenous Kaveri engine programme which has been delayed by 15 years, also attributed to sanctions imposed by the US and lack of skilled manpower and infrastructure. In the last two decades the DRDO has spent close to \$ 455 million on development of the Kaveri engine. At best, the Kaveri has developed thrust of 70-75 Kilo Newton, much lower than that required for the Tejas light combat aircraft.



Bangalore or Koraput for the last five years at least and we are all thoroughly exposed to this. The three cores will be of sizes 10kN, 25 kN and 60kN. They should all be single shaft turbojets and the stress will be on timeliness, reliability and technology security above all the other necessary aims. It is a sedulous myth that advanced features 'teach'. If advanced features are a cause of such delay as enabling the proposer (s) to retire without delivering, then 'advanced features' is de facto an accessory to a swindle.

Maximum stress should be on using materials from Mishra Dhatu Nigam Limited (Midhani). The Orpheus, designed by a 'Master', has a few interesting features which could

be replicated. The shaft is a thin-walled large diameter tube; and easily permits insertion of the second spool's shaft as was done in the case of the Pegasus which gave three times the thrust even in its earliest version (despite VTOL configuration !). We can expect more. The second Orpheus feature desirable is that it has a limited number of stages (7+1) on a short shaft and so can use just two bearings thus avoiding the third bearing and jointed shaft with its attendant proneness to whirling vibrations and, who knows, blade shedding. In fact starting point for the 25 kN could well be the Orpheus since large quantities of partly used engines must be stored at Air Force equipment depots following retirement of Kiran jet trainers. The purpose of these core engines is they will, over time, constitute a family of fan and 'leaky' engines for a variety of military and civil applications ranging from 10kN to 250 kN. They will incorporate the certificated advanced technology that GTRE will

undoubtedly develop. Certainly, GTRE's contribution will be essential for success of the programme. A side effect of the development of these small 'cores' is that any business jets can be rigged up as a flying test bed.

In a lighter vein, GTRE should quietly examine its press statements before clutching in the 'tongue'. Stories about a Marine Kaveri are allowable but to talk of a Kaveri-powered locomotive is to betray major disconnect. Not only will the engine choke in the heat and dust of central India but also the power would be so enormous, that the train length would exceed the loop line used by the Railways. Marine and Power versions are completely different matters, using different materials and operating in different ambient conditions. These derivatives will in no way help the aircraft engine programme and only recalls Northkote Parkinson's story about how a big Government funded project to make a hyper rocket fuel failed miserably but then stated the Chief of the project at a press conference "I am afraid we have failed to have a useful rocket fuel but fortunately we find it is an excellent paint remover!" The UCAV Kaveri idea is far better and on the right track.

Nil desperandum !

The Kaveri engine is in no way worse off than the LCA programme itself. What is needed, as with the LCA, is not more technology but more care and attention to detail. That will surely transform both projects if not into outstanding stupor mundi (wonders of the world) products as so tiresomely claimed but at least in serviceable and affordable equipment.

I take this opportunity to thank Ashok Baweja (Chairman HAL 2004-2009) who during a casual conversation, suggested that I do a piece on the Kaveri engine. This article has its genesis in his suggestion and is by way of thanks for the same!



The Kaveri engine and (inset) the LCA it was conceived to power.

Powering the Future



The new generation EJ200



n 1986, a requirement for a new propulsion system to power the L proposed multi-national Eurofighter Typhoon was put out. The new engine had to effectively toe the line between performance and efficiency, capable of higher thrust, longer life and less complexity than prior engines. To meet this requirement, Eurojet Turbo GmbH was formed, a consortium of Rolls-Royce of the UK, MTU (Motorenund Turbinen-Union) of Germany, Fiat-Avio of Italy and ITP (Industria de Turbo Propulsores) of Spain. Incorporating much of the advanced research carried out by Rolls-Royce on the XG-40 Advanced Core Military Engine (ACME) demonstrator, Eurojet unveiled the EJ200 a few years thereafter, as a light-weight engine with high thrust and utilising state of the art technology. Over a thousand EJ200s have since been delivered, with several hundred more units set to be delivered.

In layman terms, the EJ200 is a low bypass ratio turbofan, consisting of an eightstage compression system, a single turbine each in the high-pressure and low-pressure turbine stages and thrust augmentation systems.

Low Pressure Compressor

The EJ200 consists of a three-stage lowpressure compressor (LPC) module and a five-stage high-pressure compressor, and it is remarkable that the EJ200 low-pressure compressor provides high surge margin in absence of variable inlet guide vanes. Further advantages of this design are minimum diameter (no aerodynamic blockage) for a given engine mass flow, no ice accretion and therefore no need for heating devices and high bird strike resistance. Each stage of the LPC is equipped with wide-chord integrated blade/disk (blisk) assemblies, designed to compress the air. The usage of low-weight blisks (each stage in the LPC consists of a single blisk with no removable parts) is a major factor in the reduction of complexity easing the burden on maintenance personnel. The compressor blades of each LPC stage compresses air flowing in from the Typhoon intake system featuring a variable inlet cowl lip, prior to passing it on to the next stage. The 'varicowl' is a significant part of the design of the aircraft – increasing the capture area of the intake at low subsonic/high angle of attack slowing down incoming air as per continuity equation, and vice versa - that allows it to gather and direct optimal amounts of air to

the LPC. At the end of the Low Pressure Compression module, core air is compressed by a factor of 4.2.

High Pressure Compressor

Air is then directed to the High Pressure Compressor (HPC). The presence of only one stage of Variable Inlet Guide Vanes (VIGV) in front of the HPC in combination with the overall compression ratio of 26:1 proves the high efficiency of the compression system and at the same time leads to low parts count to achieve high reliability and minimum maintenance effort.

Like the LPC, the HPC is equipped with single blisks in the first three stages. The final two stages are traditional hub and rotor designs. As they are subject to the highest pressures and temperatures, these stages are more likely to face blade degradation. In such cases, it would be more economical to replace the damaged individual blade than an entire blisk. The HPC further compresses core air by a factor of 6.2, leading to air that has been compressed by a factor of 26. The fact that EJ200 achieves this in eight stages, far lesser than the nine or ten stages employed by engines of comparable performance, is testament to the efficient aerodynamic design of the blades.

Annular Combustion Chamber

The EJ200's annular combustor receives the highly compressed air, then a series of fuel nozzles thoroughly intersperse the air ingested with tiny droplets of fuel, termed as 'microspray.' Microspraying increases combustion-efficiency and also reduces the visible emissions of oxides of nitrogen. The key factors in determining jet engine efficiency and achievable work are the temperature and pressure differences attained between the engine inlet and combustor outlet. Although the maximum temperature of air leaving the combustion chamber is classified, the outlet stator temperature is generally reported to be 200°C higher than previous generation engines.

Turbine Stage

Downstream of the annular combustion chamber is the High Pressure Turbine



Although the picture may seem daunting, the EJ200 features fewer moving parts and reduction in complexity, making for easy maintenance

(HPT). In order to handle the large temperatures generated in the combustion chamber, the HPT uses air-cooled singlecrystal blades. Ceramic Matrix Composites (CMCs), heat resistant material that is incorporated into several leading fighter designs, is not present on the EJ200. Instead, the HPT guide vanes utilise a special Thermal Barrier Coating (TBC), composed of two plasma deposited layers, a special bonding coat over which a top layer of a Nickel-Chromium-Yttrium ceramic material is applied. Although this increases the life of the blade and increases the achievable operating temperature it does require regular inspection to ensure the coating remains viable. Following the HPT is a single Low Pressure Turbine stage, again employing single crystal blades. A titanium alloy based convergent/divergent (Con-Di) nozzle completes the engine improving achievable thrust while helping to optimise the system for different flight profiles.

Reheat Systems

Eurojet has installed an innovative threestage thrust augmentation system to supply reheat as and when required by the pilot. Downstream from the low-pressure turbine, in the exhaust duct, are the first two stages of the thrust augmenter. The first stage consists of a radial series of burners and their associated flame cups. Subsequent to this is a stage of 'primary vapourisers' that spray fine mists of fuel that combust on contact with the hot exhaust air. Finally, the third stage comprises of fuel injectors located at the back of the bypass duct. These spray fuel into the cold, oxygen rich air that has passed through the duct unburned.

DECMU (Digital Engine Control and Monitoring Unit)

EJ200's Digital Engine Control and Monitoring Unit (DECMU) provides carefree handling for the whole turbomachinery, automatically activates and controls the various stages of reheat and provides engine monitoring and executive lifting functionalities within one single unit. The DECMU was incorporated in 2007 and is equipped with two channels for redundancy, and each engine on the Typhoon has its own DECMU box.

Advanced performance

The EJ200 is a low-bypass ratio reheating turbofan. The engine is compact, approximately 4 metres in length, 800mm

(30 inches) in diameter and weighing around 1000 kg. It is similar in diameter to the RB199 that powers the Panavia Tornado, yet offering 50% more thrust and manufacturing simplicity (the RB119 has 2845 parts to the EJ200's 1800, primarily due to the use of single piece blisks and more simple engine architecture). The EJ200 generates 60kN of dry thrust and an incredible 90kN of thrust at full reheat, offering a 9.175-to-1power to weight ratio with full afterburner. This implies that the twin-engine Eurofighter Typhoon generates 180kN of thrust at full reheat, giving the aircraft the ability to achieve Mach 2 at higher altitudes. Even at dry thrust, two EJ200s pack enough power to permit the Typhoon to comfortably supercruise without the need to employ reheat. Specific fuel consumption figures vary from 49 g/ kNs using full reheat to a mere 21 -23 g/ kNs at dry thrust.

Of note is the bypass ratio achieved by the EJ200. The bypass ratio is a measure of cold air flowing around the compressor and turbine stages of the engine rather than through it. Most military turbofans have a bypass ratio of 0.1 to 1, while that of the EJ200 is 0.4 to 1. This affords the Typhoon good subsonic performance and efficiency, while at the same time has high dry thrust that offers very good supersonic qualities and a sophisticated reheat system. The increased bypass flow provides a substantial secondary flow of air that can be employed to generate additional reheat thrust. The EJ200 is also equipped with a 'war' setting, generating additional dry and reheat thrust. This setting will, however, reduce the life expectancy of the engine.

The EJ200 also effectively handles 'thrust droop' losses. Thrust droop is caused by gaps opening up between the tips of the turbine blades and the turbine casing at lower engine temperatures after cold start. The problem is rectified only after the engine has been running hot for a while and the gaps have been closed by expansion of rotors and casings. Eurojet claims to have done away with this by adopting a passive tip-clearance model using a specific selection of materials that expand and contract at different rates or different temperatures, minimising any gap that may arise between the blades and the turbine casing.

The road ahead

Since the first production model was delivered in 2001, the EJ200 has been subject to a few upgrades, but remained more or less constant. Of late, Eurojet has been conducting studies on an improved version, the EJ2x0, which would offer 20% dry thrust growth to 72kN and 103kN reheat capability. An even more powerful variant has also been discussed. These, however, remain studies, reiterates Eurojet. The EJ200 and its improved variants will be an attractive option for several aircraft in development, such as India's Advanced Medium Combat Aircraft (AMCA) which is in the process of final definition.

Sayan Majumdar

Eurojet EJ200



Helicopter Modernisation Cost effective solutions for operators

Rising prices and shrinking defence budgets have pushed armed forces the world over to consider alternatives to induction of new equipment. Upgrades and modernisation offers stateof-the-art capabilities at a fraction of the price of acquiring a new platform. With technological breakthroughs and highly advanced avionics, it is possible to make older aircraft relevant in today's airspace. This is especially true with rotorcraft. In this survey, *Vayu* looks at a few major helicopter modernisation schemes.

Israel Aerospace Industries (IAI) has long been at the forefront of helicopter modernisation and refurbishment. The Israeli firm's Lahav Division has comprehensive in-house capabilities and performs upgradation, overhaul, refurbishment and retrofits. Amongst other programmes, it is responsible for the Integrated Avionics System on the Dhruv ALH. Based on its experience with the Israel Defence Forces, Lahav developed the Operational Flight Programme (OFP) installed in their Display and Mission Computer (DMC). The upgraded avionics fit in the ALH provides generation of integrated displays for each stage of the mission, optimised system management and operation and maximised flexibility and growth potential utilising modular avionics with open architecture.

Apart from the ALH, Lahav also performs upgrades for the Mil Mi-17. Using subsystems designed for previous Mi-35 and Ka-50-2 attack helicopters upgrades, Lahav has developed the installation design of both the cockpit panels and the various avionics systems as well as adapted the cockpit to be Night Vision Goggles compatible. The tactical upgrade package expands the envelope of operation of the Mi-17 by providing full capability at night and in adverse weather, in addition to improving battlefield survivability. IAI Lahav also provides an integrated naval helicopter package, the Skimmer. Skimmer integrates equipment including radar, sonar, electrooptical sensor, datalink, electronic support measures and communications intelligence arrays, also with mission management and monitoring systems. Weapons such as anti-ship missiles can also be installed, with the system to be adapted for specific requirements ranging from anti-surface and anti-submarine warfare to amphibious assault, special operations and coastguard tasks.

One of the pioneers of vertical flight, Bell Helicopter (Textron) has extensive helicopter refurbishment and upgrade programmes. Its Ozark, Alabama facility in the US has dedicated depot level support services and maintenance hangars. The Huey II Modernisation Programme combines all new commercial dynamic components with the reliable Honeywell T53-L-703 engine in the Bell UH-1H helicopter, leading to an increase in hover performance in hot conditions. In addition, the Huey II upgrade increases the max gross weight to 10,500 lbs, while lowering direct operating costs. Bell Helicopter has refurbished the UH-1H basic airframe, provided a complete re-wire package and updated the avionics. Apart from the Huey II Modernisation Programme, Bell is also involved in the H1 upgrade programme for the US Marine Corps to replace its aging fleets of AH-1W SuperCobras and UH-1N Twin Hueys. The original contract was for upgrading existing airframes, but it has since then been changed to completely manufacture new aircraft.

Moscow-headquartered Russian Helicopters is among the largest rotorcraft manufacturers in the world, with over 8500 Russian helicopters currently in operation. Amongst its several upgrade programmes are those of the Ka-52 and Mi-26. IAI has



The ALH Dhruv features an extensive avionics fit provided by IAI Lahav

also been involved in the upgrade of Russian Helicopters-produced rotorcraft for forces around the world, including India.

Russian Helicopters has teamed up with Sagem to develop an enhanced version of the Ka-52 Alligator. The upgrade aims to integrate Sagem optronic equipment and LINS 100 inertial navigation systems. The company is also currently modifying its Mi-26 Heavy Lift Helicopters. The upgraded version, designated the Mi-26T, features BREO-26 avionics suite and a glass cockpit, a new digital autopilot and a new navigation system. The improved Ivchenko-Progress D-136-2 turboshafts are a step forward in the company's use of full authority digital engine control, and have an emergency power output of 12,500hp



(9,321kW) and increased take off power. The Mi-34 light helicopter, slated for pilot training, police and power survellaince roles, has been improved as the Mi-34C1. Russian Helicopters selected Goodrich Aerospace to provide upgraded main rotor actuator and hydraulic power supply for the light helicopter. The result is a rotorcraft with an aluminum alloy airframe, 365-shp M9VF radial piston engine and a fuel system that can withstand negative g-forces, giving it aerobatic capability.

AgustaWestland, a subsidiary of Finmeccanica, is very active on the helicopter upgradation and retrofit front. In January this year, the Anglo-Italian helicopter maker signed a £760 million two-fold deal with the British Ministry of Defence. The first deal involves upgrade of the RAF's 25 AW101 Merlin for maritime operations and transfers them to the Royal Navy (Merlin Life Sustainment Programme). The second deal encompasses providing the Apache fleet with comprehensive support and services (Apache Integrated Support Operation). By the end of the upgrade programme, the Merlin helicopters will be fully optimised for ship operations, include automatic main rotor blade folding and tail fold and will also be fitted with the same cockpit as the Royal Navy's Merlin Mk.2 aircraft, giving the Merlin fleet a common cockpit featuring five 10x8-inch integrated display units, two touch screen units for controlling the aircraft's systems and mission equipment, as well as two cursor control devices for control of the tactical displays. The Apache Integrated Support Operation involves providing the Apache AH Mk.1 Attack Helicopter fleet with



The Mi-26T is an upgraded version of the world's largest helicopter

comprehensive support and maintenance services, delivering the required levels of aircraft availability whilst reducing through life costs. In Italy, the company does the systems upgrade for the fleet of AW129C helicopters, upgrading them to AW 129C G19 standards.

AgustaWestland is also involved in the Polish market through its subsidiary PZL-Swidnik. PZL-Swidnk has been involved in the upgrade of helicopters for the Polish Ministry of Defence. The deal comprised upgrade of four W-3 Sokół helicopters to W-3PL Głuszec armed configuration, the overhaul and upgrade of eight Mi-2 helicopters and the upgrade of two W-3VIP helicopters with a FADEC (Full Authority Digital Engine Control) system.

Sikorsky from the USA, has kept pace with the modernisation industry by constantly offering upgrades and



improvements of its products. In 2010, Sikorsky began a programme to upgrade S-61 helicopters and return them to productive service. The S-61, a civilian version of the SH-3 Sea King, is undergoing upgradation to the S-61T helicopter with an integrated glass cockpit and enhanced performance capabilities. Sikorsky is under contract with the U.S. Department of State (DoS) for refurbished S-61 aircraft, with over 16 already having been delivered.

Sikorsky incorporated improvements on several UH-60s in operation with the US Army in the early 2000s, before being awarded a contract for production of new helicopters based on the upgraded version. The company has performed A-to-L upgrades on the Royal Saudi Land Forces fleet of UH-60 rotorcraft. The A-to-L upgrade programme incorporates key improvements consisting of a T700 to T701D engine upgrade for increased power and reliability, and upgraded flight controls, avionics and instrument panel modifications. Additionally, each upgraded helicopter will be equipped with a new Aircraft Flight Control Computer (AFCC) as well as new wiring harnesses, a high-speed shaft and a sealed lead acid battery.

Eurocopter was renamed Airbus Helicopters at the start of the year, but save the name, not much has changed for the European rotorcraft manufacturer. The company continues to produce high-performance helicopters, while its upgrade programmes remain on track. The enhancement programme for British SA330 Puma helicopters involved the use of new Makila 1A1 turboshaft engines, the integration of a full glass cockpit

IAI LAHAV





incorporating modern avionics, the implementation of a digital automatic flight control system; as well as the incorporation of a secure communications suite, new defensive aids and ballistic protection for crew and passengers. The upgrade also provides the Puma with greater onboard fuel capacity and lower fuel consumption.

Airbus Helicopters has also been involved in upgrading 40 of the Bundeswehr's CH-53G to CH-53GA standard. The CH-53GA is equipped with state-of-the-art avionics and communications systems. Pilots are now be able to make use of a fouraxis autopilot with auto-hover automatic flight control system, as well as an up-todate electronic warfare system for threat recognition and electronic self-protection. In another enhancement, navigational accuracy is brought up to international instrument flight rules (IFR) standards, with the upgrade extending to display and control functions. The upgrades include an infrared observation system in the form of a forward looking infrared (FLIR) system, a satellite communications package, along with auxiliary fuel tanks that extend the aircraft's range up to 1,200 km. As part of the refit, weaknesses in the helicopter airframe arising either from age or use also are being addressed and the wiring renewed.

Vijay Matheswaran

Elbit to upgrade US Marine Corps AH-1W's

Elbit Systems of America, LLC, a wholly-owned subsidiary of Elbit Systems, Ltd., has been awarded two contracts, totaling \$14.1 million, supporting the U.S. Marine Corps' upgrade of their Bell AH-1W attack helicopter fleet.

One contract, amounting to \$11.6 million, calls for Elbit Systems of America to provide helmet display tracker system (HDTS) kits on the aircraft. The HDTS significantly improves flight safety by providing crewmembers greater situational awareness with enhanced night vision, weapons sighting, and weapons control capabilities. Additional HDTS capabilities include improved safety in degraded visual environments, such as brown out, fog or weather-related conditions.

The second contract, worth \$2.5 million, will add tactical video data link (TVDL) technology to the helicopters. TVDL provides aircrew information needed



to detect, identify and quickly respond to threats. The information can be received via on-board sensors or from external sources such as ground troops or other aircraft. Additionally, the information can be communicated back and forth, so all forces in a given area, on the ground or in the air, will have the same intelligence data when making mission-critical tactical decisions. The contract will be performed over a 15-month period.

IAI's Heron - the Unmanned Sentinel



The Super Heron Heavy Fuel (HF) multi-role MALE UAS seen at the Singapore Airshow in February 2014

The fourth generation Heron/ Machatz 1 Medium-Altitude Long-Endurance (MALE) Unmanned Aerial Vehicle (UAV), designed and manufactured by Israel Aerospace Industries (IAI) at its Malat division, entered operational service with the Indian Air Force for high-altitude land surveillance missions along the land borders as well as in the maritime patrol role.

The Heron is capable of fully automated take-off and landing sequences, even under adverse weather conditions. Cruising at an altitude of 30,000 feet, the UAV provides operators with realtime information on enemy activities, functioning as an Intelligance, Surveillance, Target Acquisition and Reconnaissance (ISTAR) asset capable of covering wide areas. Using multiple sensors and satellite communication (SATCOM) for extended range capture and transfer of critical data, information is instantly passed on to national agencies, theatre commanders and lower echelons. IAI is reportedly to supply around 50 Heron MALE UAVs to various branches of Indian Armed Forces, but IAI officials have declined to confirm whether the agreement also includes supply of the newer Heron TP/Eitan.

Powered by a single 115 hp Rotax 914 turbocharged piston engine manufactured by Austria's BRP-Powertrain, the UAV has a climb rate of 150 metres per minute and can fly at a maximum speed of 207 km/h to a range of 350 kilometres. The Heron has demonstrated 52 hours of continuous flight time in tests. With designed space for up to 250 kg of customer furnished equipment, the

Heron can carry Electro-Optical (EO) and Infra-Red (IR) sensors (supplied by Northrop Grumman and Tamam Division of IAI), thermal surveillance equipment and a laser designator. While the EO sensor converts light rays into electronic signals for capturing images, real-time data and videos, the laser designator is applied for targeting enemy units on the battlefield. Thermal surveillance equipment allows capture of high-resolution images by penetrating through clouds, rain, smoke, fog and smog. Communications are established through direct Line-of-Sight (LoS) datalink, UAV airborne data relay for beyond LoS missions and ground-based data relay for communicating with the Ground Control Station (GCS). Additionally, Electronic Support Measures (ESM) helps the Heron in threat detection and examines the area to determine signals emitted from surrounding radars and other emitters.

In maritime roles, an automatic identification system (AIS) gathers details of ships such as vessel type, name and destination. The ELTA Maritime Patrol Radar (MPR) identifies vessels from very long distances by applying silhouette target acquisition procedures. MPR also provides Synthetic Aperture Radar (SAR) images and can detect surface vehicles using its Ground Moving Target Indicator (GMTI) mode.

The Heron can be controlled either manually from the GCS or operated in autonomous mode. As mentioned earlier, it is equipped with an automatic launch & recovery (ALR) system that helps in automatic safe landing during communication failure with the GCS. The processing, retrieving and storing of real-time data provided by Heron UAV is undertaken by the GCS to convert sensor data, including EO, SAR, MTI maps, SIGINT and ESM, into actionable intelligence.

An enhanced Heron variant, the Heron TP (also known as the Heron 2 or Eitan), developed under an Israel Ministry Of Defence programme, can carry multiple payloads and perform multiple missions such as Communication Intelligence (COMINT), Signal Intelligence (SIGINT) and Image Intelligence (IMINT). Making its maiden flight on 15 July 2006, these UAVs have entered service with the Israeli Defence Forces (IDF). The Heron TP can fly at 45,000 feet with an endurance of approximately 36 hours. Apart from long range, long endurance ISTAR missions, the Heron TP is designed to execute a large variety of operational missions, including aerial refuelling and strategic missile defence. These new UAVs will provide the Israel Air Force with persistent, high altitude, long endurance (HALE) ISR capability well beyond the reach of enemy air defences and far beyond Israeli borders. A single 1,200 hp Pratt & Whitney Canada PT6A turboprop powers the Heron TP, this powerful engine enabling the aircraft to climb and operate at altitudes above 40,000 feet, thus avoiding any airspace conflict with civilian air traffic. Using on board fuel and power resources, Heron TP is able to sustain continuous missions for over 36 hours with full mission payload and is also equipped with de-icing systems protecting the aircraft when flying through icing conditions.

With a maximum takeoff weight of 4,650 kg, the Heron TP can carry over 1,000 kg of sensors distributed among its forward section, main payload bay, and the two bulges located at the end of each tail boom, offering optimal separation for specific systems. Other stores can be mounted along the wing, in internal and external positions.

The UAV can also be fitted with wing hard-points for external stores. The aircraft is equipped with multiple datalinks, supporting LoS and Beyond Line-of-Sight (BLoS) links via satellite communications. The giant drone maintains the twin tail boom design for stability offering a large payload bay located around the aircraft's centre of gravity, uninterrupted by the landing gear, which allows for quick and simple payload reconfiguration on the flight line.

Sayan Majumdar



New F-35 flying records

The Lockheed Martin F-35 Lightning II aircraft fleet, which surpassed 16,000 cumulative programme flight hours to date in April, flew a monthly record high for *System Development and Demonstration* (SDD) with 282 flight hours and 153 flights in April 2014 itself.



Operational F-35s fleet-wide flew 812 hours, with SDD F-35 aircraft flying 282 flight hours in this one month. In 2014, through April, F-35A test aircraft flew 420 hours; F-35B test aircraft flew 281 hours; and F-35C test aircraft flew 222 hours. Operational F-35s of all three variants flew 2,790 hours for the year. Operational F-35s at Eglin Air Force Base, Fla., flew 515 flight hours in April, and operational F-35 at Marine Corps Air Station Yuma, Ariz., flew 172 hours. Eglin's 33rd Fighter Wing is home to 48 F-35A/B/ Cs and provides training for US military and programme partner nation pilots and maintenance personnel. Yuma is home to the Marine Corps' first operational F-35B Short Takeoff/Vertical Landing aircraft. Among the record SDD flights, the F-35B version completed its 700th vertical landing, and it began crosswind takeoffs and landings and expeditionary operations.

New F-16s for Oman

The first of a second batch of Lockheed Martin F-16C/D Block 50 Fighting Falcons was delivered to Oman on 3 April, during a ceremony held at Fort Worth Texas to mark the occasion. Oman has ordered ten F-16Cs and two F-16Ds via a Foreign Military Sales



(FMS) contract. The initial batch of aircraft are due to be ferried to Oman later this year and the last will be handed over by November 2016, to equip a second squadron with the type. Oman received its first batch of 12 F-16C/Ds in 2005.

Chinese II-78s and Ukraine

China's military relationship with Ukraine is exemplified by Ilyushin Il-78s of the People's Liberation Army Air Force (PLAAF) as seen in Ukraine during March. The Chinese government had signed a \$1.5 billion contract with Russia for the delivery of 34 new Ilyushin Il-76MD transports and four Il-78 tankers in 2005 but this contract was not fulfilled by the Tashkent Aviation Production Association in Uzbekistan, where these were initially built, which forced China to seek Il-76s on the open market. 14 were purchased in the early 1990s, four of which were converted as KJ-2000 airborne early warning and control aircraft. A further ten former Russian and Belarusian Il-76MD/TDs were acquired and overhauled in Russia. In April 2013, additional aircraft were acquired and overhauled in Ukraine, including some tankers, which include three Il-78s and five Il-76MDs, the first of which refurbished by the Nikolaev Aircraft Repair Plant flew in March.



Meanwhile, Pakistan had ordered 4 II-78MP aircraft from Ukrainian surplus aircraft stocks, fitted with removable fuel tanks and UPAZ refuelling pods, the first of which was delivered in December 2009.

Impact of Scotland's Independence

A nticipating an 'independent Scotland', following the referendum due on 18 September, the Royal Air Force (RAF) will be relocating some of its fighter squadrons. The two Eurofighter Typhoon squadrons currently based at RAF Leuchars, Fife, will relocate to RAF Lossiemouth along with Nos. 1 and 6 Squadrons before RAF Leuchars is handed to the army. RAF Lossiemouth will then take over the 'northern Quick Reaction Alert,' while a third Typhoon unit (No II Squadron currently flying Tornados at RAF Marham, Norfolk), will stand up at the base in April 2015, completion of the relocations to coincide with the Scottish independence referendum.

As of early 2014, the Ministry of Defence (MoD) had made no provisions for a 'yes' vote to Scottish independence, although that possibility would have a major impact on British military bases in



the country and RAF Lossiemouth in particular, as it will be the last such 'north of the border'. The Scottish National Party (SNP) has envisaged operating at least 12 and possibly upto 16 Typhoons from RAF Lossiemouth for the air policing role. According to the SNP, the fighters would come from RAF stocks as part of military resources to be negotiated from the United Kingdom. However, recent disbandments will leave the RAF with only seven frontline fighter squadrons; No.3 and No.X on the Typhoon at RAF Coningsby Lincolnshire; the two Typhoon units at RAF Leuchars and No.II, No.IX (Bomber) and No.31 with Tornado GR4s at RAF Marham. In early 2014, the RAF had 117 Typhoons and 102 Tornados in service with availability running at 73 percent and 70 percent respectively, according to the MoD.

'Dambusters' to be first RAF F-35B Squadron

No.617 Squadron will re-form in 2018 as the RAF's first operational Lockheed Martin F-35B Lightning II unit, with some 48 numbers to be acquired in the first ten years of the procurement programme. In addition to replacing the already retired Harrier GR9 fleet and the Tornado GR4 (due to be withdrawn in March 2019), the F-35Bs will also form the core of the air wing of the Royal Navy's *Oueen Elizabeth*-class aircraft carriers.



The bulk of these requirements are expected to be fulfilled by the initial 48 F-35Bs, enough for three to four squadrons shared between the RAF and Fleet Air Arm. The total number to be acquired will be announced during the *Strategic Defence and Security Review* in 2015 and additional procurement in the later 2020s will reportedly supplant the Typhoon fleet.

Swiss Air Force 'Readiness'

Stung by global criticism about its levels of combat readiness, the Swiss Government has launched Project II ILANA. The Swiss Air Force does not usually have quick reaction alert aircraft available to conduct interceptions outside "normal business hours", which was demonstrated in February 2014, when the Service failed to respond to a hijacked Ethiopian Airlines Boeing 767, which went on to land at Geneva, before air force operations started at 0800hrs.

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Project ILANA (*Interventionsfähigkeit des Luftpolizeidienstes ausserhalb der normalen Arbeitszeit*— intervention ability of the air force outside normal working hours) is intended to provide Switzerland with a round-the-clock operational capability, 365 days a year, by 2020. Approximately 100 new personnel, including pilots, controllers and technicians will support this effort even as the referendum on the procurement of Gripen fighters was imminent (see separate item).

Swiss National referendum

Further to the decisions by the Swiss Parliament in 2013 to procure 22 Gripen Es, a national referendum was held on 18 May 2014 in Switzerland on the funding law for Gripen. The result was 'no' which means that the Gripen E procurement process in Switzerland will not continue. However, the Gripen E programme in Sweden continues according to plan, with development and production of 60 Gripen E for the Swedish Air Force with deliveries scheduled for 2018.

In February 2013, Saab had signed a framework agreement with the Swedish Defence Materiel Administration (FMV) concerning the development and production of 60 Gripen E for Sweden and potentially 22 to Switzerland. The referendum result on the funding law for Gripen means that the Swiss procurement process of 22 Gripen E 'stops'. The Swedish development and production orders placed in 2013 continue, with delivery of Gripen E to Sweden commencing in 2018. The negotiations regarding 36 Gripen NG to Brazil are ongoing and according to plan with the plan of

both parties that an agreement should be signed in 2014.

"We respect the process in Switzerland and do not comment on the outcome in the referendum. Following selection in 2011, hundreds of business relationships in Switzerland have been created through the Swiss Industrial Participation programme, which was created in relation to the Gripen E procurement. These are relationships we look forward to continuing as long as possible," observed Håkan Buskhe President and CEO of Saab.





First A400M for Turkey

A irbus delivered the first A400M to the *Türk Hava Kuvvetleri* (THK, Turkish Air Force) on 4 April at a ceremony held at Seville-San Pablo Airport, Spain. The A400M will be operated by *Hava Ulastirma Ana Üs Komutanliği* (12th Air Transport Main Base Command) at Kayseri-Erkilet for training on the type. The THK has ordered ten A400Ms.



South Korea receives C-130Js

The first two Lockheed Martin C-130J-30 Hercules for the Republic of Korea Air Force (RoKAF) were handed over during a ceremony at Marietta, Georgia on 27 March, departing for South Korea on 1 April. South Korea had ordered four C-130J-30s in December 2010, the first of which was rolled out on 11 June 2013 and made its maiden sortie on 14 August. The other pair is due to be delivered in mid-June.



S Korea to lease F-16s as lead up to F-35

The Republic of Korea Air Force (RoKAF) is considering leasing between 20 and 60 Lockheed Martin F-16C/D Fighting Falcons from the US Air Force to act as interim replacements for F-4E Phantom IIs and F-5E/F Tiger IIs as they are phased out of service over the next five years. In the longer term, the F-16C/Ds would be replaced by Lockheed Martin F-35A Lightning IIs, which are due to be deployed between 2023 and 2025. Forty will be acquired as part of the FX-III fighter programme in a deal reported to be worth \$6.8 billion.

A new Lavi

Israel's first Alenia Aermacchi M-346 advanced jet trainer (called Lavi) was rolled out on 20 March 2014 at Venegono Superiore in Italy, the aircraft carrying out its maiden flight five days before the event. The M-346 was selected by Israel to replace the McDonnell Douglas TA-4 in the advanced and lead-in fighter training roles at Hatzerim AB. Thirty M-346s were ordered on 19 July 2012



for operation by the TOR Advanced Flight Training consortium. A joint venture by Israel Aerospace Industries and Elbit Systems, TOR will also manage and support the aircraft while they are operated by the air force. The M-346 was christened Lavi ('Young Lion') by the Israeli military in July 2013, a name previously used by the indigenous fighter programme, which was cancelled in the late 1980s. Initial deliveries are due to take place in summer 2014 and operational training on the aircraft should commence in 2015.

100 MiG-35s for Russian Air Force

Over the next few years, Russian Aircraft Corporation-MiG will manufacture around 100 MiG-35 fighters for the Russian Ministry of Defence. The formal contract for delivery of these fighters is expected to be signed after 2016, and purchase of the new combat aircraft will enable "an optimum fleet correlation to



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be established between light and heavy fighters in the Russian Air Force," according to the Russian Ministry of Defence. The Russian Ministry of Defence has already reached an agreement with MiG on the delivery of 16 MiG-29SMT (upgraded MiG-29B) fighters worth around \$474 million.

The acquisition of new generation fighters is part of a programme to modernise Russia's armed forces by 2020. In accordance with this programme the existing aircraft and helicopter fleets will be "almost completely updated." With this in mind provision has been made for acquisition of more than 600 fixed-wing combat aircraft as well as around 1000 helicopters for a variety of roles.

Russian Victory Day Parade

A total of 69 aircraft, 149 military vehicles and over 11,000 troops featured in Moscow's Red Square parade on 9 May 2014, held to mark the 69th anniversary of Russia's victory in World War II. According to a Russian Air Force spokesperson, 69 aircraft were chosen as the number symbolises the 69th anniversary of victory in the *Great Patriotic War* (as World War II is known in Russia). A total of 17 aviation groups were deployed during the parade, and aircraft included Su-24M and Su-34 bombers, Su-25 ground attack aircraft, Su-27 and MiG-29 fighters, MiG-31BM interceptors along with a host of military transport aircraft, refueling aircraft and military helicopters.



USAF to retire entire U-2, A-10 fleets

In a move to manage significant budgetary constraints, the United States Air Force has submitted plans for the complete retirement of its A-10C attack aircraft fleet in 2015 as well as all its U-2 reconnaissance aircraft in 2016. These measures have been described as "drastic but necessary" by USAF officials, but have encountered resistance from the public, the US Congress, as well as other branches of the US military that rely on the capabilities of these two aircraft.

While the USAF is adamant that the missions carried out by these two aircraft types can be adequately fulfilled by other inservice assets, there are reservations as to the veracity of that claim and the United States House Committee on Armed Services, which funds and oversees the US Department of Defence, has



formulated provisions that limit the USAF's options on retirements. The A-10s, for example, can be removed from service only if the USAF maintains them in 'Type-1000' storage whereby they can be reactivated into service readily if needed.

The U-2 retirement meanwhile appears to have been stymied by the Committee, which noted that the capability gap between the U-2 and its proposed unmanned replacement, the RG-4 Global Hawk, indicates that there would be significant losses in ISR generation should the U-2 be prematurely retired.

Dutch Apaches in Mali

Four AH-64 Apache helicopters of the Dutch Air Force (Koninklijke Luchtmacht) have been airlifted in chartered An-124s from the Netherlands to Bamako in Mali in support of the UN mission based there. The Apache helicopters will be used for reconnaissance and defensive tasks in the African country. Later in 2014, three CH-47 Chinook helicopters with 70 supporting personnel will be transported to Mali, to become operational in September-October 2014. Gilze-Rijen is the main helicopter base of the Dutch Air Force where the Apaches and Chinooks are based. All Dutch military helicopters are operated and controlled by the DHC (Defensie Helicopter Commando, or Defence Helicopter Command); the DHC commands all helicopters like NH-90, Chinook, Cougar, Apache, Alouette, Agusta AB-412. (Courtesy: Joris van Boven)





The Pampa III IJT

Work continues towards bringing the Argentinian IA-63 Pampa jet trainer back into production. During the FIDAE 2014 airshow in Chile, the company displayed a mockup of the proposed Pampa III, equipped with three Elbit Systems multifunctional displays. The Martin-Baker Mk 10 ejection-seat will replace the Russian Zvezda design initially considered. Two prototypes and 22 production Pampas were originally produced, the final six built as Pampa IIs when Lockheed Martin owned. The Pampa first flew on 17 October 2007and construction of a further six was started but abandoned, when the company was nationalised in 2009. These partially finished airframes are currently being completed as Pampa IIIs.

It is learnt that the Pampa III was one of the types offered to meet the IAF's IJT requirement, for which an RFI was issued earlier this year (*see Vayu II/2014*).

Major arms purchases planned by Qatar

Qatar has revealed plans to spend \$2billion on new military equipment and airborne early warning aircraft, tanker transports and battlefield and naval helicopters. The recently announced procurement programmes highlight the rapid growth planned for the Qatar Emiri Air Force, which currently operates one squadron of Dassault Mirage 2000-5DDA/EDA fighters and another of Alpha Jet Es for close air support. From late 2009, it established a transport capability with the delivery of four C-130J Hercules and four C-17A Globemaster IIIs, while an air academy is being established that will train pilots on 24 Pilatus PC-21 trainers.

Three Boeing 737 Airborne Early Warning and Control aircraft are required, along with two Airbus A330 Multi-Role Tanker Transports. An FMS contract for 24 Boeing AH-64E Apache Guardian attack helicopters will be concluded with the US Government. Twelve NHIndustries NH90 Tactical Transport Helicopters will provide battlefield mobility, while ten Naval Frigate Helicopter versions will also be supplied for maritime operations. Qatar also has an outstanding requirement for between 64 and 72 new fighters, with the Boeing F/A-18 Super Hornet, Dassault Rafale, Eurofighter Typhoon and Lockheed Martin F-16 Fighting Falcon having been offered.



Algeria orders Mi-28s and Mi-26s

Algeria has ordered 42 Mil Mi-28N Night Hunter attack helicopters and six Mil Mi-26T2 heavy lift helicopters from Russia, the deal worth approximately \$2.7 billion. This covers the modernisation of 39 Mi-171SH (Mi-8AMTSh) helicopters, which will be upgraded at the Ulan-Ude Aviation Plant in the Russian Republic of Buryatia. Algeria had first expressed interest in acquiring 42 Mi-28s in mid-2010 and Russian Helicopters recently flew a Mi-26T to Algeria for demonstration flights.



Grob G120As in Kenyan Service

The Kenyan Air Force has reportedly received six Grob G120A-K basic training aircraft, the contract for six aircraft signed last July, with options on six more. A delivery ceremony for the first three KAF Grobs was held on 5 November at the Tussenhausen-Mattsies factory in South Germany, by which time KAF pilots were already being trained on the type with company pilots in Germany. The aircraft are being used in the pilot training role by the Training Squadron (Flying School) at Moi Air Base, which also operates the SAL Bulldog Srs103/125 and Shorts Tucano Mk 51. The G120As will replace the Bulldogs, which are being phased out of service.





L-159As for Iraq?

Acro Vodochody L-159A Advanced Light Combat Aircraft to Iraq has been announced. The Czech Air Force had 40 single-seat L-159As in storage, but the sale of 28 to the US military services contractor Draken International took place in November 2013, leaving 12 L-159As potentially available for Iraq. The previous Iraqi deal covered 28 two-seat L-159T1s - and included four aircraft originally delivered to the Czech Air Force and 24 newly built examples.



Airbus Defence and Space HC-144A for US Coast Guard

A irbus Defence and Space has delivered the 17th HC-144A Ocean Sentry maritime patrol aircraft to the US Coast Guard. The Ocean Sentry is based on the Airbus CN235 tactical airlifter with more than 235 currently in operation by 29 countries. The latest aircraft will join a fleet of 16 Ocean Sentries operating from US Coast Guard Air Stations in Cape Cod, Massachusetts; Mobile, Alabama, and Miami, Florida. The Coast Guard is planning to stand up the fourth HC-144A air station in Corpus Christi, Texas, later this year. The HC-144A achieved initial operational capability with the Coast Guard in 2008.



AgustaWestland in Italian Air Force training agreement

O n 19 March 2014, AgustaWestland, a Finmeccanica company, and the Italian Air Force signed a Letter of Intent aimed at future establishment of joint training solutions. The announcement was made at the official ceremony after maiden flight of the first HH-101A Caesar helicopter for the Italian Air Force held at Yeovil plant, UK.

The partners intend to co-develop new capabilities to meet future rotary-wing training requirements by leveraging synergies between the AgustaWestland Training Organisation based at its Frosinone plant, close to Rome, and the Italian Air Force 72nd Wing (72° *Stormo*).



Cambodian MA60s

Seen below is one of two Xi'an Aircraft Manufacturing Company MA60 transport aircraft delivered to the Royal Cambodian Air Force at Siem Reap. Two MA60s were ordered from China in February 2012 with both now delivered and operated by the Transport Squadron at Phnom Penh International Airport.



PAF Base Mianwali named after 'MM Alam'

Prime Minister Muhammad Nawaz Sharif unveiled a monument on 20 March 2014 to mark the official renaming of Pakistan Air Force (PAF) Base Mianwali Base as *PAF Base MM Alam*. The ceremony was followed by the PAF JF-17 Thunder, F-16, F-7P, Mirage and K-8 making a flypast. During the Indo-Pakistan War in 1965, MM Alam was CO 11 Squadron, flying the Sabre.

PAF Base MM Alam presently houses No37 (Combat Training) Wing and its subordinate units, Nos 18 and 19 Operational Conversion Units, both equipped with F-7Ps and FT-7Ps. It also houses No 1 Fighter Conversion Unit with the K-8P Karakoram, together with No.86 Squadron and the Station Flight, both flying Alouette IIIs. No. 19 Squadron has meanwhile received the first six re-furbished F-16s of 13 being procured from Jordan.



Russian Deputy Defence Minister visits Irkut

A senior Russian Ministry of Defence delegation headed by the Deputy Defence Minister Yuri Borisov has visited Irkutsk aviation plant (IAP), a branch of JSC Irkut Corporation and inspected manufacturing processes of Su-30SM fighters and



Yak-130 new generation combat trainers. Irkut President Oleg Demchenko stated that in recent years the company has invested heavily in the modernisation and development of its human resources, while discussing future production plans for the Russian military. In December 2011 the Russian Ministry of Defence and Irkut Corporation had signed a contract to supply the Russian Air Force with 55 Yak-130 by the end of 2015, with Russian air force cadets already training on the first batch of these aircraft. Irkut is also a prime contractor and is actively working on the MC-21 new generation airliner programme.

Air search for MH370

After the search for MH-370 was called off, multinational Aircrew and aircraft involved in operation 'Southern Indian Ocean' searching for the missing Malaysian B-777 airliner assembled for a photo at RAAF Base Pearce in Perth, Western Australia. Seven nations, including Australia, New Zealand, the USA, South Korea, Malaysia, China and Japan, flew daily search missions out to the southern Indian Ocean in the massive multinational hunt for the missing Malaysia Airlines Flight 370.



(photo: Australian Defence Force)

US Navy contract to Sikorsky

Sikorsky Aircraft has won an initial \$1.24 billion contract to develop and build six new US presidential helicopters, the first step toward a fleet of 21 new aircraft by 2023. These helicopters will be based on Sikorsky's S-92 utility helicopters, suitably modified





for the Presidential/VIP transport role. The contract comes after years of efforts by the US Navy to replace the current fleet of aging VH-3 'Marine One' helicopters, also built by Sikorsky, which first began service in 1961. Notably, Sikorsky has built all presidential helicopters since 1957, when Dwight Eisenhower became the first US president to regularly use helicopters. An earlier programme to replace the Presidential helicopter fleet, led by Lockheed in cooperation with AgustaWestland, was canceled in 2009, owing to an escalation of costs in a period of austerity following the 2008 financial crisis.

The total value of the new Sikorsky programme is expected to be about \$3 billion, with Lockheed Martin remaining involved, this time as a key subcontractor to Sikorsky. Sikorsky was the sole bidder for the contract after other companies elected not to compete in the fixed-price RFP that intended to leverage mature systems integrated with a production rotorcraft to minimise costs

Fully configured MC-27J makes first flight

n 25 April 2014, a fully configured MC-27J multi-mission tactical transport aircraft, being developed in partnership with ATK made its first flight from Alenia Aermacchi's Turin Test Flight Centre. The demonstrator aircraft was modified with an L-3 Wescam MX-15Di Electro-Optical and Infrared Turret mounted under nose of the aircraft and optimised for ISR (Intelligence, Surveillance and Reconnaissance) and SAR missions (Search and Rescue); and with Link-16 datalink software and hardware provisions that will prepare the aircraft for the ATK palletised mission system installation. Provisions for upgraded Selex ES communication system with crypto capability have been also been made. The installation of both the ATK developed modular rollon/roll-off mission and weapon system, and a modified side door for the GAU-23 30 mm cannon installation will be completed in May, leading to a new series of flight tests, including firing the side-mounted cannon.



Farewell to the RAF TriStar

On 24 March 2014, the RAF bid official farewell after 30 years of TriStar operations. *Vayu's* UK editor Richard Gardner was aboard the very last air-to-air tanking sortie that day, when two TriStars spent three hours flying over the North Sea refuelling a succession of Typhoon and Tornado combat aircraft. The ex-airline TriStars are very large aircraft and the 500 Series that were bought for the RAF have an extended range allowing them to fly long non-stop missions in either the refuelling role or as strategic passenger and freight aircraft.



Text and photos of the final day of RAF TriStar operations by Richard Gardner

Nine aircraft were purchased and some were converted with large cargo doors and others had centreline or wing pods for flight refuelling large aircraft or fighters. The freighter versions were particularly useful for carrying bulky ground equipment in conjunction with overseas deployments of operational squadrons to such locations as the USA and the Middle East or Afghanistan. TriStars also provided the long-range twice weekly passenger and cargo scheduled flights between the UK and the Falklands, with another permanently based tanker TriStar based in the Falklands in support of resident Typhoon air defence fighters. The TriStars at RAF Brize Norton are now being replaced by a new fleet of 14 Airbus A330 MRTTs, the type also recently selected by the Indian Air Force.

Thales Systems in Turkish CN-235s

Thales has announced the delivery of the final standard for the maritime patrol aircraft to Turkey as part of the MELTEM II programme, for which Thales is the prime contractor. To date, five of the six CN-235 aircraft have been delivered to this standard, with the sixth set for delivery before the summer, which follows the three maritime surveillance aircraft that were sent to the Turkish Coast Guard last year. Overall, MELTEM II involves 3 CN-235 maritime surveillance aircraft for the Coast Guard, 6 CN-235MP planes for the Navy, and 10 AMASCOS systems.



US'Sixth Generation' fighters

N ew aircraft programmes included in the United States fiscal year (FY) 2015 budget include the US Air Force's proposed 'sixth generation' fighter, planned as a replacement for the Lockheed Martin F-22A Raptor and possibly, the US Navy's Boeing F/A-18E/F Hornet, in the 2030s. Meanwhile, an aircraft type will be downselected for the USAF's T-X trainer programme in FY2017. According to the FY2015 budget request, \$600 million will be spent on the project over the next five years under the provisions of the *Future Years Defence Plan* (FYDP). Another decision concerning new Long-Range Strategic Bombers has a funding level of \$914 million in FY 2015 and \$11.8 billion over the course of the FYDP.



Airbus 'E-Fan' aircraft in public demonstration

The first public flight of the electric E-Fan experimental aircraft was highlight of Airbus Group's E-Aircraft Day held on 25 April 2014 in Bordeaux, France. The electric E-Fan training aircraft is an experimental demonstrator based on an all-composite construction. Airbus Group and its partners plan to perform research and development to construct a series version of the E-Fan and propose an industrial plan for a production facility close to Bordeaux Airport. Airbus Group's research efforts support the environmental protection goals of the European Commission, as outlined in its 'Flightpath 2050' programme.



Airbus, Dassault and Alenia joint approach on European UAS

Europe's Industry is ready to develop a next generation advanced European Unmanned Aerial System (UAS), following the call for development of a European drone during Paris Airshow 2013.

Airbus Defence and Space, Dassault Aviation and Alenia Aermacchi have delivered a proposal for further defining a European UAS to the Ministries of Defence of France, Germany and Italy. The offer proposes a Definition Phase which has been prepared by joint development teams of Airbus Defence and Space, Dassault Aviation and Alenia Aermacchi and which is backed by an industrial agreement on workshare and a cooperative agreement to start the MALE2020 programme.

The definition phase foresees that the three nations define and adjust their requirements for a European UAS development together with their armed forces and the European industry. The definition phase also serves to avoid costly additional developments during production and to reduce financial and development risks to a minimum. A commitment by the nations on the further development of the European UAS has then to be made after finalising this definition phase, with certification by 2020.

Airbus Helicopters and Avicopter in agreement for 1,000 helicopters

A irbus Helicopters and China's Avicopter (the rotorcraft unit of Chinese state corporation AVIC) have signed a joint agreement for the production of 1,000 new-generation EC175/AC352 rotorcraft. This was in presence of Chinese President Xi Jinping and French President François Hollande at the Elysée Palace in Paris. The agreement cements the industrial partnership between Airbus Helicopters and AVIC on the jointly-developed EC175/AC352. France and China launched their cooperation on EC175/AC352 in 2005, drawing on 40 years of close ties between the partners on previous rotorcraft projects.



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While development work has been equally shared between Airbus Helicopters and Avicopter for the EC175/AC352 project, production is likewise shared, combining the capabilities of both companies. Coming from a common platform, two different rotorcraft are being built: the AC352, assembled and supported from China by Avicopter, mainly for the Chinese market; and the EC175, assembled and supported by Airbus Helicopters from Marignane, France, for the worldwide market.

Aero Vodochody supplies KC-390 fuselage

The first Czech-built rear fuselage for the Embraer KC-390 military transport and tanker aircraft was airlifted to Brazil in mid-March. Under a contract signed in 2011, Aero Vodochody is producing the rear fuselage, cargo ramp, all cabin doors and the wing fixed leading edge of the KC-390. The KC-390 is intended to meet Brazilian Air Force requirements and has attracted interest from other countries in Latin America and elsewhere. In addition to Brazil, which has ordered two prototypes and 28 production aircraft,



commitments have been received from Argentina (2), Chile (6) and Colombia (12) in Latin America, while in Europe, the Czech Republic (2) and Portugal (6) are other prospective customers. As part of the proposed offset agreements for the 36 Saab Gripen NGs, Sweden may also purchase a number of KC-390s and EMB-314 Super Tucanos. The KC-390 prototype is expected to fly before the end of 2014 and service entry is scheduled for 2016.

Optionally-piloted Black Hawk demonstrator helicopter in first flight

In cooperation with the US Army, Sikorsky has successfully demonstrated optionally piloted flight of a Black Hawk helicopter, a significant step toward providing autonomous cargo delivery functionality. The Optionally Piloted Black Hawk (OPBH) Demonstrator, known as Sikorsky's Manned/Unmanned Resupply Aerial Lifter (MURAL) programme, conducted the successful first flight demonstration on 11 March at Sikorsky's Development Flight Centre. The demonstration was conducted through the use of Sikorsky's Matrix Technologies and advanced Ground Control Station (GCS) Technologies. The MURAL Programme is



a cooperative effort between the US Army's Aviation Development Directorate (ADD), the US Army Utility Helicopters Project Office (UH PO) and Sikorsky.

Sikorsky unveils new CH-53K helicopter

On 6 May 2014 Sikorsky Aircraft Corporation officially unveiled the first CH-53K heavy lift helicopter, the newest variant of the CH-53 series that the US Marine Corps expects to begin operational service by 2019. During the rollout ceremony, which was attended by members of Congress, the Department of Defence, major programme suppliers, international guests and company employees, the Commandant of the Marine Corps General F. Amos also introduced the name for the new aircraft: the 'King Stallion.'





The CH-53K boasts almost triple the external load carrying capacity of the previous CH-53E helicopter and will be able to move more than 27,000 lbs over a mission radius of 110 nautical miles. The CH-53K is a comprehensive upgrade of the venerable CH-53 that has been in service for decades, now featuring GE Aviation's new T408 turboshaft, providing 57 per cent more power with approximately 20 per cent lower specific fuel consumption.

Pilatus introduces 2014 PC-12

Incorporating new technology and responding to customer feedback, the new 2014 PC-12NG will include six new BMW Designworks executive interior options, a new electric landing gear system, external LED lighting, a wireless Connected Flight Deck system, and a Wi-Fi passenger entertainment system.



2014 marks 20th anniversary of the certification of Pilatus' PC-12, and global demand for the PC-12 NG remains strong as the company approaches the 1,300th delivery. Base price for the 2014 PC-12 NG is \$3,850,000 with a typically equipped executive configuration priced at \$4,642,000.

IAI contract for Air Defence Radars

Israel Aerospace Industries (IAI) was recently awarded a new contract for advanced dual-use civilian and military airspace control and protection radars, for an "undisclosed customer". The Air Defence radar configuration consists of the ELM-2288



AD-STAR Air Defence and Traffic Control Radar and the ELM-2106NG 3D Tactical Air Defence Radar. Both systems are designed and manufactured by IAI's Elta Systems subsidiary. The AD-STAR ELM-2288MR (Medium Range variant) is an advanced 3D solidstate long-range S-Band family of transportable radars designed to support air defence, early warning and traffic control activities. Featuring fully digital beam-forming in elevation, the AD-STAR provides high accuracy 3D data on detected targets at ranges exceeding 300 km.

Qatar contract for SIGMA 30 on PzH 2000 artillery system

S agem (Safran) has signed a contract with German manufacturer KMW (Krauss Maffei Wegmann) to integrate its SIGMA 30 navigation and pointing system on all PzH 2000 tracked artillery systems acquired by Qatar. Sagem designed the SIGMA 30 pointing system to give long-range artillery quick, high-precision firing capability without GPS. Because of its performance capabilities, it allows deployment by distributed artillery pieces, boosting mobility and protection by support units. The SIGMA 30 operates independently within the artillery system, protecting it against jamming and other countermeasures.



Based on digital laser gyro technology with a long optical path, SIGMA 30 reflects Sagem's proven expertise in the production of navigation systems and inertial sensors. With this latest contract, Sagem has further consolidated its offering of navigation and pointing systems to armies worldwide. SIGMA 30 systems have been selected for some 40 artillery systems in 20 countries, including the Archer system (BAE), the Nexter Systems by Caesar for France and international markets, the Nora wheeled system (SDPR), the M270 Mars 2 single-launch rocket system for NATO (Airbus Defence Systems), and the 2R2M mobile mortar (Thales).

Raytheon awarded first international contract for Paveway IV

Raytheon received a contract from an "undisclosed international customer" for Paveway IV precision-guided bombs valued at more than \$200m. As part of the sale Raytheon will deliver hundreds of the advanced munitions, which are regarded as the 'weapon



of choice' for the Royal Air Force and represents the first sale of Paveway IV outside the UK. The Paveway family of laser-guided and GPS-and-laser-guided bombs has 'revolutionised' tactical air-to-ground warfare by converting 'dumb' bombs into precisionguided munitions.

Boeing Delivers 8,000th 737

B oeing has delivered the 8,000th 737 airliner to United Airlines, the Next-Generation 737-900ER sporting a special logo to commemorate the event. United was the first airline to order and take delivery of the 737-200. Since 1965, United has taken delivery of more than 550 737s and operated nearly every model. The wider 737 programme has a healthy backlog with more than 3,700 airplanes on order, including 1,934 orders for the new 737 MAX.



Irkut's record revenue in 2013

JSC Irkut Corporation (a UAC company) has announced record revenues for 2013 amounting to US\$ 1.9 billion, 24% higher than in 2012. Gross margin in 2013 was 26% (against 24% in 2012) and net profit for Irkut also increased to US\$ 36.6 million, as compared to US\$ 32.1 million in 2012. These positive results were achieved because of increased deliveries of multirole Su-30SM fighters and Yak-130 combat trainers as well as a number of export deliveries.

Dassault's manned and unmanned aircraft in formation flight

On 20 March 2014, Dassault Aviation conducted a formation flight of the nEUROn unmanned combat air vehicle (UCAV) alongside a Rafale fighter and a Falcon 7X business jet, the first time that a combat drone has flown in formation with other aircraft. The entire operation lasted 1 hour and 50 minutes and took the formation out over the Mediterranean to a range of several hundred kilometers.

In his statement, Eric Trappier, Chairman and CEO of Dassault Aviation, said that "organising such a formation flight was a challenge: for each manoeuvre in the planned sequence, aircraft from different holding points and with very different flight characteristics had to fly alongside each other in a confined space".

An additional challenge was being able to control a pilotless aircraft flying near four other aircraft, all manned (Rafale, Falcon 7X and two chase aircraft for photography). Engineers had to plan ahead to take into account the risk of interference, including aerodynamic turbulence between the aircraft, not to mention electromagnetic interference (EMI) with communications between the nEUROn drone and its ground control station.



Sberbank and Irkut in agreement for delivery of 20 MC-21 airliners

At the MAKS airshow in Zhukovsky, JSC Sberbank Leasing and JSC Irkut Corporation (part of UAC) concluded a supply agreement for 20 MC-21 next generation airliners, the document signed by Chief Executive of Sberbank Leasing, Dmitry Yeroshok, and President of Irkut Corporation Oleg Demchenko. The agreement has a total catalog value of US\$ 1.7 bn and the aircraft are planned to be delivered in the period of 2019-2025.

Also Ilyushin Finance Company and Irkut Corporation signed a firm contract for 22 MC-21-300 passenger airliners, with delivery

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of aircraft to begin from 2019. This contract is an implementation of the option clause for 22 aircraft under the previous agreement to acquire 50 aircraft of this type by the IFC leasing company, which was signed earlier.



Russian Helicopters restructuring

Russian Helicopters, a subsidiary of Oboronprom, part of State Corporation Rostec, are "restructuring and upgrading their production capacities and streamlining management processes." At a meeting of the company's Collegium on 24 April 2014 held at Kazan Helicopters (a Russian Helicopters company), it also reviewed the production efficiency and its future development. The Collegium noted the substantial progress made on the company's core projects in 2013. More than 800 new pieces of equipment were installed at Russian Helicopters facilities to improve production safety and reduce the company's environmental footprint. Significant successes were achieved by the company's investment projects, including completion of the technological development of machining, plating and composite production.



Lufthansa orders CFM LEAP-1A

In April 2014, Deutsche Lufthansa ordered CFM International's LEAP-1A engine to power 15 Airbus A320neo and 25 A321neo aircraft, valued at more than US \$1.0 billion at list prices. In addition, the airline has also selected the LEAP-1A engines to power incremental A320neo family aircraft orders. Lufthansa currently operates a fleet 350 CFM56 engines powering the Airbus A319/ A320, four-engine A340-300, and Boeing 737 Classic aircraft. Overall, the Lufthansa Group, which also includes Germanwings, Austrian, and Swiss, operates more than 560 CFM56 engines.

The first full LEAP engine began ground testing in September, and recently successfully completed a series of early icing tests, one year ahead of required certification testing. CFM will shortly complete early endurance testing and is on track to begin flighttesting both the LEAP-1A engine at GE facilities in California.

Air Canada orders LEAP-1B engines

A ir Canada has finalised its order for 122 LEAP-1B engines to power 61 Boeing 737 MAX airplanes. The value of the firm engine order is US\$ 1.6 billion at list prices. The airline, which has been a CFM operator since 1990 and currently operates a fleet of 89 CFM56-powered aircraft, also has options and rights to purchase an additional 96 LEAP-1B engines. The LEAP-1B is the sole powerplant for the Boeing 737 MAX scheduled to go into production in 2017.

Japan Transocean Air orders CFM56-7B engines

Japan Transocean Air (JTA) announced the purchase of CFM56-7B engines to power 12 Boeing Next-Generation 737-800 airliners. The engine order is valued at \$260 million at list price, and the contract offers JTA the flexibility to switch to the LEAP-1B, used to power the Boeing 737 MAX. Based in Naha, Okinawa, JTA is a member of the Japan Airlines Group and a long-time CFM customer. The airline currently operates a fleet of CFM56-3-powered 737-400 airplanes on domestic routes linking Okinawa with major Japanese cities as well as other islands within Okinawa.

AVIATION & DEFENCE NEWS

First Trent XWB for Qatar Airways





Rolls-Royce has delivered the first production Trent XWB that will power the Airbus A350 XWB's entry into commercial service with Qatar Airways later in 2014. The Trent XWB, "the world's most efficient aero engine" and specifically designed for the A350 XWB, is the fastest-selling civil large engine ever, with more than 1,600 already sold to 40 customers. Qatar Airways has ordered 80 of the aircraft (43 A350-900s and 37 A350-1000s). The engine powered the A350 XWB's first test flight in June 2013 from Toulouse, France. Since then the aircraft has carried out a variety of test flights, including high altitude testing in Bolivia, hot weather testing in Al Ain, UAE, and cold weather testing in Iqaluit, Canada. The engine also powered the A350 XWB's visit to the Singapore Airshow in February 2014.

Comair places LEAP-1B engine order

South African private domestic airline operator Comair Limited has announced an order for LEAP-1B engines to power eight Boeing 737 MAX 8s, making Comair the first African airline operator to order the new 737 MAX. This engine order supports Comair's long-term objective of investing in future technology to ensure continuous sustainability. Comair currently operates an all-Boeing fleet of 25 Classic and Next-Generation 737s powered by CFM56-3 and CFM56-7B engines, respectively, on its *kulula. com* and British Airways (operated by Comair) brands. The airline has four additional Next-Generation 737-800 aircraft on order and scheduled for delivery in 2015 and 2016.

Over 100 ATRs ordered in 2014

A TR has announced that over 100 of its regional turboprop Airliners have been ordered in the first four months of 2014, with the ATR-600 series leading the way. These sales represent over 80% of total orders for regional aircraft below 90-seats announced so far. ATR's commercial results achieved in the first four months of the year have already surpassed those of 2013 with firm orders for 89 ATR -600s. Till date, ATR has announced orders for the United Arab Emirates' leasing firm DAE (20 firm ATR 72-600s plus 20 options) and 6 firm ATR 72-600s for the Canary Islands-based Binter Canaria. Beyond these firm orders for 26 ATR 72-600s and 20 options already announced, ATR has booked 8 additional contracts for 81 firm aircraft plus 41 options.

300th UH-72A Lakota for US Army

A irbus Group delivered the 300th UH-72A Lakota helicopter on 14 May 2014 to the US Army, "on time and on budget". The Lakota is manufactured at the company's Columbus, Mississipi plant. The company has delivered the Lakota in seven different configurations for missions including training, border security, search and rescue, medical evacuation, disaster response, VIP transport and range support. Five aircraft are also in service with the US Naval Test Pilot School, which trains Navy, Marine Corps and Army test pilots.

Army officials have recently indicated plans to modernise the service's rotorcraft training fleet with the UH-72A.



The Pilatus PC-24 'Super Versatile Jet'

Pilatus Aircraft announced first contracts for its new business jet at the European Business Aviation Conference & Exhibition (EBACE) held in Geneva from 20 to 22 May 2014. As Oscar J. Schwenk, Chairman of the Board of Directors, commented, "The PC-24 project was unveiled to the general public exactly a year ago. The interest from potential customers has been overwhelming ever since. It was soon clear to us that our new aircraft occupies a unique but typically Pilatus market niche. For everyone at our factory in Stans who is involved in this project, it is a source of motivation and reward to know that we have already found the first customers for our new business jet, even though it is still undergoing development. The sales registered at this year's EBACE are another major milestone in the PC-24 project."



The rollout of the first prototype will go ahead on 1 August 2014, which also happens to be the Swiss National Day. Three prototypes will be built for the PC-24 flight test programme, the maiden flight is scheduled for early 2015. Certification and first deliveries to customers are planned from 2017 onwards.

Sea trials for FREMM Normandie

The FREMM *Normandie* multi-mission frigate, second of the series ordered by OCCAR on behalf of the DGA (*Direction Générale de l'Armement*) and the French Navy, left the DCNS site in Lorient on 14 May on its way to the DCNS site in Toulon



to perform a new series of sea trials to test performance of the FREMM's combat system before delivery to the French Navy at the end of 2014. This series of sea trials, which took place in the Mediterranean, will allow the Navy's operating crew and the DGA, OCCAR and DCNS specialists to check on performance of the main combat system sensors and their integration into the frigate's Combat Management System.

During these trials, the teams on board simulated different operational scenarios to collect the information delivered by the vessel's different sensors. Numerous tests were performed including, in particular, electronic warfare and tactical data link tests. Further to these trials, the FREMM *Normandie* will return to the DCNS site in Lorient so that the final finishing work can be carried out over the summer before its delivery to the French Navy in the final quarter of 2014.

MBDA's next generation Anglo-French anti-ship missile

MBDA has received a 'Demonstration and Manufacture' Contract for the FASGW(H)/ANL (Future Anti Surface Guided Weapon (Heavy)/ *Anti Navire Léger*) missile, this jointly funded Anglo-French contract, being valued at over £500 million (€600 million). This has been awarded by the UK DE&S (Defence Equipment & Support) on behalf of the French and UK MODs and will be managed as part of MBDA's Team Complex Weapons Portfolio. The work will complete the joint assessment and missile design work funded by the two nations in cooperation since 2009.

The FASGW(H)/ANL will equip the Royal Navy's AW159 Lynx Wildcat helicopters and the French Navy's NH90s-NFHs. Weighing around 100kg, the anti-ship missile will engage targets ranging from fast inshore attack craft (FIAC) to corvettes from safe stand-off ranges. In addition, the missile also has a surface attack capability against coastal and land targets.



MBDA progresses with MMP demonstration

MBDA's MMP (*Missile Moyenne Portée*) programme has passed a major phase in its development, with demonstration of firing capabilities of the missile in operational configuration. The launch tests were carried out in a confined space in the presence of the operator, using his firing post, and the team leader. MMP is a new generation land combat missile based on the concept of 'fire and forget' with the facility for 'man in the loop' operation. The missile, which can be fired from a networked infantry firing post or from a vehicle turret, features a wide range of functions, one of which is firing on coordinates which allows non line of sight targets to be engaged.



MBDA's Naval Cruise Missile

On 8 April 2014, the French DGA (*Direction Générale de l'Armement*) carried out the second qualification firing of the naval cruise missile (MdCN or *Missile de Croisière Naval*) currently under development by MBDA. The firing took place at the DGA's Biscarrosse missile test centre and was representative of a firing from a frigate, demonstrating the missile's flight capabilities at high altitude. MdCN is to equip the French Navy's multi-mission frigates (FREMM) and its *Barracuda* submarines. Having a range of several hundred kilometers, MdCN is intended for strikes against targets deep inside hostile territory, and complements the SCALP air-launched cruise missile from which it is derived.



Colombian *Almirante Padilla*-class frigates

Thales and DCNS have announced that the comprehensive modernisation programme of the Colombian Navy's four *Almirante Padilla*-class frigates has been concluded with a successful Sea Acceptance Test of the class's fourth ship. The contract with the Colombian authorities was signed early 2009, with DCNS acting as prime contractor and Thales as the lead systems integrator for the combat system and communications suite.



Under this modernisation programme, Thales and Colombian

shipyard Cotecmar have installed and integrated the SMART-S Mk2 surveillance radar, STING EO Mk2 electro-optic weapon control system, MIRADOR optronic weapon control system, VIGILE 200S electronic support measures (ESM) system, communications systems and Terma's SKWS decoys launching system, on the four *Padilla*-class ships. Thales has also modernised the vessels' Altesse communications intelligence (COMINT) systems.

IAI's full digital shipborne radar

Israel Aerospace Industries (IAI) has completed installation and integration of two ELM-2248 MF-STAR radars installed aboard corvette and frigate class battleships for two different navies. The MF-STAR, designed and manufactured by IAI's Elta Systems subsidiary, is a multi-function digital solid-state active electronically scanned array (AESA) radar system for the new generation of naval platforms, the radar system delivering a high-quality situational picture and weaponry support. IAI's MF-STAR 4D fully digital AESA shipborne radar is considered to be among the most advanced shipborne radars in its class on the market and is customised according to customer's requirements and vessel type.



A Manner of Numbers No.5 Squadron ('Tuskers') Indian Air Force

n the eve of Independence, the fledgling Royal Indian Air Force consisted of ten squadrons, these being sequentially numbered from No.1 Squadron which was formed in 1933 to No.12 in the closing year of World War II. However, while the RIAF had been greatly expanded during 1942-44, anticipating a Japanese invasion of the subcontinent, Nos. 5 and 11 Squadrons had been left out of such sequential numbering owing to the presence of similarly numbered squadrons of the RAF then stationed in India. There was no room for confusion in those war-torn years !

The need for a heavy bomber element in the Indian Air Force was felt soon after independence in August 1947. An offer by the RAF to supply war-surplus Avro Lancaster bombers was considered, as was a proposal by the Americans to sell B-25 Mitchells. Instead, in a move that in hindsight proved to be a remarkable decision, the Indian Air Force decided to resurrect Consolidated B-24 Liberators used by the Air Command South East Asia (ACSEA) during the war, large numbers of which had thereafter been abandoned at the Care and Maintenance Depot at Chakeri airfield at Kanpur. Thus was taken the decision which resulted in formation of No.5 Squadron, the IAF's first bomber unit.



The Tuskers are presently equipped with HAL-built and upgraded Jaguar Darin IIs. (photo: Angad Singh)





No.5 Squadron, the IAF's first bomber unit, was formed with Consolidated-Vultee B-24 Liberators

Under command of Wg Cdr JRS Dantra, No.5 Squadron was formed in November 1948 in Kanpur, equipped with an initial six Liberators which had been meticulously refurbished by HAL. The unit adopted the 'Tusker' as their emblem, relating the strength and destructive capability of their bomber aircraft with the pachyderm, and '*Shakti Vijayete*' or 'Strength is Victory' as their motto. The Squadron had humble beginnings, making do with minimal personnel and support equipment, and make-shift accommodation.

From Kanpur, they soon moved to Poona which was to remain their base through till 1957, their awesome presence being felt over the Deccan area till they moved to Agra, when supplanting the Liberators with Canberra jet bombers.

No.5 Squadron was reequipped with the English Electric Canberra on 1 September 1957, which tactical jet bomber was to serve as their steed for the next quarter century, the Tuskers first charging at Katangan mercenaries in the jungles of Central Africa and thereafter through two full scale wars with Pakistan in the decade 1961-1971.





Tuskers in the Congo

In mid-1960, Congo had got its independence from Belgian rule but the transition from colony to independent nation was anything but smooth. The breakaway province of Katanga, backed by mercenaries and Belgian troops, began an armed movement to secede. The United Nations thereafter sent ground forces from several countries, including India, to preserve the unity of Congo and soon enough, needed ground support aircraft in addition. The UN requested the Indian Air Force to participate and it was No.5 Squadron with its Canberras that were selected for the unusual assignment. The Canberra's operational range and presence of a navigator and navigational aids were seen to be quintessential for the Congolese environment, as was its heavy front gun armament consisting of four 20mm cannon with 535 rounds each. On



Drawing by Derek Bunce depicting Tusker Canberras destroying the Katangan Air Force at Kolwezi

9 October 1961, the Tuskers departed Agra for Leopoldville in the Congo to join a unique air contingent which included Ethiopian F-86 Sabres, Swedish Saab J29s, Italian Fairchild C-119 Packets and a combined UN Dakota squadron. Under Wg Cdr AIK Suares, the Tuskers settled into a routine of intensive reconnaissance missions and showing-the-flag formation flying. Initially, the United Nations Air Commander had been instructed not to use force. However, by November 1961, intelligence reports suggested a massive Katangan troop build-up at Kolwezi, poised to strike at Elizabethville, then held by a battalion of Indian troops, and the go-ahead was finally given to take necessary action in early December.

In their first 'offensive' mission led by Wg Cdr Suares, six Canberras of No.5 Squadron, in three waves of two aircraft each, carried out precision attacks on enemy targets. The first pair was tasked with attacking and destroying the Kolwezi airfield, while the rest were given coordinates to bomb areas where Katangan troop concentrations and convoys were reported.

Situated at a distance of 800 miles away, carrying out this long range strike was no easy task, with a blanket of clouds adding to the aircrew's difficulties. The plan of action was to converge on a lake that lay to the west of Kolwezi, and map read the final stretch to the airfield using the 'Green Satin' navigation aid. As Wg Cdr Suares dived to break cloud, he spotted six to seven light transport/communication aircraft and a heavy transport aircraft refuelling close to the control tower. At one end of the airfield, in a jungle clearing was the dreaded Fouga Magister that had been carrying out incessant raids against UN troops in Kamina. "I took out all the light aircraft with my 20-mm cannon on the first low level pass attack," Suares recalled, "whilst Flt Lt P Gautam, flying the second Canberra, destroyed the Fouga Magister. We made a rapid turn and, on the second pass, I concentrated on the heavy transports and control tower. On the third and last pass I saw that all the parked aircraft and the control tower were ablaze, so we both hammered away at the stacked fuel barrels, the adjacent hangars and the buildings."

Wg Cdr Suares then led a second raid on Kolwezi, the Squadron arming their Canberras with alternate high explosive and incendiary rounds. Flying through a storm of muzzle flashes and small arms fire, the Canberras hit the petrol storage tanks lining the side of the airfield, debilitating the remainder of the airfield. On his third pass, Wg Cdr Suares heard a dull thump and realised his aircraft had been hit in the nose. A check revealed that his navigator, Flt Lt MM Takle had been struck in the upper thigh. Pulling up through the cloud, he set the controls on auto and climbed down to Flt Lt Takle and applied a tourniquet on his thigh, before recovering to base.

The Canberras of No.5 Squadron continued to fly operational sorties and reconnaissance missions, including a raid to relieve the pinned down Indian troops on 9 December 1961 and fire support during the battle for Elizabethville. The Tuskers were well decorated for their services in the Congo, Wg Cdr Suares awarded a bar to his Vir Chakra, while his navigator Flt Lt Takle was also awarded a Vir Chakra. Flt Lt P Gautam was decorated with the Vayu Sena Medal, and five others were awarded VSMs.

Wars in the sub-continent : September 1965

The clouds of war had gathered over the subcontinent and in September 1965, the second Indo-Pak war was fought over a three-week period, until the UN-mandated ceasefire on 23 September. The Tuskers were quick off the mark, carrying out offensive sorties deep inside hostile territory.

Based at Agra and led by the redoubtable Wg Cdr Prem Pal Singh, the Tuskers flew a total of 486 hours, 344 of them by night. On the night of 6 September, the Squadron hit the strategic PAF airbase at Sargodha and subsequent raids had the Tuskers striking Chaklala, Akwal, Kohat, Chak Jhumra and Risalwala. For his tenacious and gallant leadership, exemplified by the six missions he personally flew between 6 and 9 September, Wg Cdr Prem Pal Singh was later decorated with the Maha Vir Chakra.



Wg Cdr PP Singh (later Air Marshal and Commodore Commandant) and his navigator, Flt Lt HS Mangat during the 1965 Indo-Pak war

No.5 Squadron made their deepest raid into enemy territory on the night of 13-14 September, bombing air bases at Peshawar and Kohat, damaging the runway and POL installations in the face of incessant ack-ack fire. This mission is also remarkable for the spectacular raid by a Canberra crewed by Sqn Ldr Charanjit Singh and his navigator, Flt Lt HS Mangat. After dropping flares to illuminate the area, they came in low over Peshawar air base before pulling up and dropping a single, massive 4000lb bomb. As learnt later, but for the bitumen shoulder that absorbed much of the destructive force, the entire line-up of 16 PAF B-57s would have gone up in a fireball, knocking out virtually half of Pakistan's bomber force.

By end of the war, over 200x1000lb bombs had been dropped, countless rockets fired and 20mm cannon rounds expended. The Tuskers had conducted numerous raids



Canberra releasing stick of 1000lb bombs



May 1981: last formal Canberra flypast by No.5 Squadron: Composite photo of seven bombers with their aircrew standing in exact order
and provided close air support to the Army, all while running the gauntlet of anti-aircraft fire and interception by fighters. On the final day of the war, one Tusker Canberra was lost to a Sidewinder missile fired by an intercepting F-104 Starfighter.

For their gallant efforts in September 1965, No.5 Squadron was awarded one Maha Vir Chakra, four Vir Chakras, three VSMs and fourteen mention-in-despatches.

Déjà vu in December 1971

For the third time in less than a quarter century since their Independence, India and Pakistan were drawn into an all-out war in December 1971. The IAF had been on operational readiness since October 1971, anticipating an armed conflict over the worsening crisis in East Pakistan. When it finally came, the Tuskers were more than up to the task.

Pre-emptive airstrikes by the PAF on 3 December 1971 hit several IAF airfields in northern India, including Agra where No.5 Squadron was based. Nevertheless, the first Tusker Canberras were airborne by 2150

hours, merely six hours later. With Wg Cdr MS Talwar as the CO, the Squadron operated in groups of four or five aircraft, striking at major PAF bases at Sargodha and Shorkot Road in counter - air raids on the night of 3-4 December. Sargodha would be the target of Tuskers' Canberras several times over the course of the next 24 hours, with eleven of the eighteen sorties mounted being against that important PAF base. Single aircraft strikes were flown in the course of the next two days, but all efforts were then re-oriented towards interdiction and close-air support for the hard pressed Army in the Chhamb sector. Supply and communication lines were interdicted and the Squadron acted against enemy armour advancing in Chhamb, mounting six sorties. On 8 and 9 December, 5 sorties were flown to Chhamb, 3 to Raiwind and 2 against the Jassar railways yards. On 10 December, three missions were flown in the Chhamb area and three bombing missions against the Lodhran railway yard.

On receiving reports of enemy armour concentrations at Sulemanki, three sorties

were mounted against this target, led by the CO. Carrying heavy loads of 2x4000 lb bombs each, the Canberras scored direct hits on the targets, impeding the enemy's intended advance. The Canberras of No.5 Squadron were not restricted to the Western theatre, three raids being flown against targets near Dacca in the east on 15 December. On the last day of the war, a two aircraft strong force led by Wg Cdr MBS Talwar bombed Skardu airfield in Pakistan occupied Kashmir.

The two-week conflict came to an end on 17 December 1971 with signing of the instrument of surrender by Lt Gen Niazi in Dhaka. The fortnight of furious fighting had seen No.5 Squadron fly a total of 306 hours, bomb vital enemy air bases and installations and provide air support to the Army. For their efforts, the Squadron was decorated with one MVC (to the CO) and three VrCs. Their operational record and elan was recognised by the award of the President's Colours to the 'Tuskers' on 9 April 1975, the first IAF bomber unit to be so honoured.





Wg Cdr M Matheswaran (later Air Marshal and Commodore Commandant) commanded the Squadron from January 1995 to March 1997

Tuskers go supersonic

The Tuskers were finally stood down as a Canberra unit in May 1981, slated for conversion to the Sepecat Jaguar Deep Penetration Strike Aircraft (DPSA). Under Wg Cdr JS

Sisodia, No.5 Squadron were stood up at Ambala on 1 August 1981, switching from the Canberra to the supersonic Jaguar. Initially, the Squadron's 'Direct Supply' Jaguars were equipped with an avionics suite known as the NavWASS [Navigation and Weapon-Aiming Sub-Systems] fit, broadly comparable to the avionics fit in the RAF's Jaguar GR1 variant. Later production examples of the IAF's Jaguar fleet received a second-generation avionics configuration, known as the DARIN [Display Attack Ranging Inertial Navigation] fit, followed by a DARIN II upgrade and then DARIN III, which is currently being carried out.

With their new steeds, No.5 Squadron continued to perform when called upon to do so. The eighties and early nineties saw the Tuskers take part in various exercises and fire power demonstrations. The Squadron was placed on alert in the run-up to *Operation Brasstacks* as tensions flared on either side of the border. Shortly after, the Tuskers were part of *Operation Pawan* in support of the Indian Peace Keeping Force in Sri Lanka. Taking off from locations well inside



peninsular India, the Jaguars of No.5 flew long-range tactical reconnaissance missions, overflying the Jaffna peninsula and then returning to base. The Squadron remained on alert, but in the eventually, was not called upon to carry out strike missions should the situation have demanded.

During the summer of 1999, with the Indian Army and Air Force involved in repelling hostile occupation of areas in the Kargil sector, the Tuskers were placed on alert and moved to their ops-location, the aircraft modified to carry laserguided bombs. Throughout the two-month operations, No.5 Squadron maintained aircraft serviceability at exceptionally high levels, remaining ready for action at short notice.

Much like the previous two eras, the Jaguar age too has been one of excellence for the Tuskers, adjudged 'Best Supersonic Squadron', 'Best Bombing Squadron' and 'Best Fighter Squadron' on numerous occasions. As they have throughout their chequered history, the Tuskers have set extremely high standards for themselves. Their performances in theatres of conflict within and outside the Indian subcontinent, the scores of gallantry awards bestowed upon them and the countless *Eklavya* trophies are testament to this.

Now, in their sixty-sixth year of existence, No.5 Squadron, true to the motto of the Indian Air Force, continues to 'touch the sky with glory' and shall do so for the times to come.

Based on: **'Tusker Charge: Illustrated History of No.5** Squadron' authored by Pushpindar Singh and published by The Society for Aerospace Studies in March 2014.

Vijay Matheswaran











Profiles of an IAF Hawker Hunter F.56A, PAF Canadair Sabre and map of Bangladesh from acig.org.

Getting the Facts Right

Air Marshal (retd) Harish Masand reviews aspects of the book

agles Over Bangladesh', an account of Indian Air Force operations during the 1971 Indo-Pak war on the eastern front, is a book at least three decades overdue. Undeniably this was the finest hour of the Indian Air Force, which had rapidly recovered from 'stalemate' of the 1965 war and applied the lessons learnt to achieve classic air supremacy which paved the way for quick and decisive victory before the big powers (or other interested parties) could intervene, at the least on the eastern front - albeit over a much weaker foe.

Compilation of the events leading to this war and those conducted by the Indian Air Force during this war is something that the Service should itself have undertaken or sponsored – soon after the war. This would have not only been a record of this glorious chapter, but for posterity, for future generations of airmen and military analysts to learn, debate and refine with detailed analysis through subsequent research.

Alas, this did not happen, so Jagan Mohan and Samir Chopra, already well known in aviation circles, having earlier authored a book on the Indo-Pakistan air war of 1965 had to fill the bill. Jagan is known as repository of information on most major air forces in South Asia, and particularly the Indian Air Force. The years of painstaking research that these two have done to bring out this book is obvious to anyone who goes through it, even cursorily. The effort is even more commendable since the events described in the book took place over four decades back and time tends to make official records and memories get



erased or destroyed, or difficult enough to find. The book is not just a tribute to those who participated in this war, but also to determination and indefatigable energy of the two authors. I, being one of those having participated in this war in the eastern front, was eager to read through the text and relate it to my recollection of the events of the war.

Although the effort put in by Jagan Mohan and Samir Chopra to collect and compile the historical material into a narrative is highly commendable, first of its kind to cover the air war on the eastern front, it must be recorded that in some places, the authors seem to have relied on the recollections of just one or two individuals instead of getting the complete story, particularly from the younger formation members whose memory was likely to be more updated ! This lacuna has led to some inaccuracies in the narrative of events and sometimes raises doubts on the actions taken by the individuals as well as the claims and counter claims. I put this as a suggestion for any future research into this war and for strategists to derive conclusions from candid events. However, since I too was involved in a limited portion of the war and that too from one base, Hasimara, I can perhaps quote some examples to support this suggestion. The first, and perhaps the most important one, concerns the attack on the Governor's house on 14 December 1971 described on page 330 where it is stated that the first pair of Hunters from Hasimara, led by 'Suppi' Kaul had only front-gun ammunition. By then, with complete air superiority over East Pakistan, we were flying with impunity at medium levels, both to increase our radius of action with additional armament load as also to improve visibility and sighting of targets while staying above ack-ack and small arms fire. All four aircraft flown by both pairs carried T-10 rockets and a full load of 30mm front gun ammunition. We arrived over target at about 15000 ft and descended to 6000 ft in an orbit to locate the Governor's house and position ourselves for an attack on the largest window on the first floor, just right of the main entrance below the dome where we expected the meeting room to be. I clearly recall all our rockets go clean through this window because of the steep dive we were in and then fired a long burst of cannon on the same spot in the second pass. While initially exiting at high speed and low levels to make tracking

by anti-aircraft guns difficult, I also clearly recall a horde of onlookers on roof of the Intercontinental Hotel : we went so close that I could almost see their faces. I recalled this to Suppi Kaul about inaccuracies in this narrative and he agreed with me.

The other incident is the one described on Page 276 on Flying Officer Rajesh 'Laloolee' Lal's forced landing at Cooch Behar. I was leader for that mission and clearly recall the sequence of events. Just after we finished the attacks and turned northwards towards home, Laloolee called up to say he had lost power and even at full throttle, was barely getting 210 Knots at the 3500 feet that we had pulled up to after the attacks. Laloolee wanted to eject immediately but I told him we had a zerolevel ejection seats and could wait a little before pulling the handle. I asked Laloolee to maintain course and a speed of 230 Knots in a slight descent which I think was the best glide speed of the Hunter getting the best distance of this power-assisted glide. While Lal did that, I kept weaving from one side to another just over him at tactical speeds to provide him tail cover and to protect him just in case we got bounced.

While we were chugging along like this, losing height steadily, Squadron Leader AA Bose, the senior flight commander, who was also airborne on another mission, came on the R/T and asked Lal to eject. Sqn Ldr AM 'Mascy' Mascarenhas, just below him in the hierarchy, immediately called, "Khappe is handling it, let him do it". Laloolee and I agreed to wait till 500 feet which would be safe enough for him to eject and by which time we would be well in our own territory as per my estimates. While we were passing through about 1000 ft, I saw Cooch Behar airfield to our left at about 10 O'Clock and 3-4 miles away. Cooch Behar was about 1200-1500 yards long and I asked Laloolee whether he could put the aircraft down there. Laloolee replied in the affirmative. My reasoning was also that his aircraft, BA 347, was one modified with cameras for the FR role and we had precious few of these. It was not borrowed from No.17 Squadron as has been claimed in the book. Lal gently turned left and headed for an approach to Cooch Behar. I kept monitoring his approach from a little above him while weaving over him. Laloolee did very well and touched down right on the dumbell at start of the runway but perhaps owing to the sun being right in his eyes with a south

westerly runway direction of about 240, he misaligned the aircraft a bit and, soon after touch down, went off the runway to the left. All the same and despite considerable damage to the aircraft, the aircraft stopped just short of the fence and I saw Laloolee jump out and run as far as he could in case the aircraft caught fire. I even recall calling out, "Run for your life, Laloolee' on the R/T just to let everyone know Lal was safe even though I knew Lal couldn't hear me. Lal only had 60-70 hours on the Hunter at that time and was U/T Ops. Considering his limited experience and the way he calmly handled the situation I recommended him for an award, at least a Vayu Sena Medal, but for reasons not known to me, this never came through. Still, we were flying more for adventure and could hardly be bothered about awards, which were not in our calculation at all.

Even description of the first air battle from Page 114 onwards, has inaccuracies which will not stand scrutiny by a serious air war historian. My own episode was posted on Bharat Rakshak by Vikram 'Polly' Singh, based on my article "The 04th of December 1971". Quite obviously this and my comments posted on Polly's write-up were used by the author for their narration. However, some distortions still seem to have crept in there. As far as I recall, we were the first formation from Hasimara, mission number 501 with a ToT of 0705h over Tezgaon. However, that does not really distort the combat in any significant manner except to the extent whether we encountered the first pair of Sabres. Sqn Ldr Mascrenhas' aircraft had not started on the ground and I had taken No. 3's position in the formation. We were flying 181 nm to Tezgaon one way with our radius of action at low level being 167 nm with 2 minutes combat reserve. We had thus used up our combat reserves completely and that is why MiGs were supposed to take care of any aerial threats. The same combat actually ate into my diversionary fuel and that is why, despite having climbed to medium level and maintaining range speed on the way back, I landed with no fuel even for an overshoot.

It happended like this. We were flying in broad frontage with 'Suppi' about 1500 yards abreast on my right and 'Billoo' Sangar in fighting position about 250 yards from Suppi. The pair of Sabres I spotted were at 3 o'clock 5 miles away, obviously under radar control in a typical parallel quarter attack and swung to our 6 o' clock in a controlled fashion, having spotted us through the course of positioning. They did not swing from our right to the left, as the book mentions. The lead Sabre positioned himself behind Suppi's pair while the trail Sabre eased himself behind me thus trailing a little more, all this time in a right turn (and not left turn as mentioned in the book). Around 90 degrees of our hard turn to the right, when Suppi's pair was coming up right ahead of me, the lead Sabre eased his pursuit to avoid being sandwiched by me. I had to continue the turn to get cover from Suppi's pair as per the standard combat tactics. After about 180 degrees of turn, I rolled out expecting Suppi's pair to be on my left at 9 o'clock from which they would have been able to check my tail for further tactical action. Instead, I saw a pair of Hunters at about 8 o'clock in a mild right turn still passing through a southwesterly heading with a Sabre about 400 yards behind the No.2 Hunter with the Sabre's guns emitting puffs of black smoke. Thinking that Suppi may have slackened his

turn rate somewhere and during the turn the lead Sabre had reversed after crossing me to latch onto Suppi's pair again, I immediately called out "Suppi, he is firing at you, continue HARD right".

In hindsight, this pair was obviously that of 'Buster' Bains doing a lazy turn at 250 Kts or so and presenting little difficulty in firing at Buster. As the wingman behind the leader, I immediately went into a hard left turn and then reversed to the right behind the Sabre closing in very rapidly since I was still at about 420 Knots having maintained tactical speed. After firing at the Sabre from less than 100 yards, I called out "I got him" and flew through the centre of his exploding debris and perhaps missed being hit by anything. In the meantime, one of the MiGs, who had arrived over the scene reacted to my call of "I got him" by responding, "Yes, I see him, he has ejected". As I was turning right to the north to get home, I had called out to Suppi "continue right and roll out 350" but saw no one on the left when I rolled out. Obviously, Buster's pair did not respond to my calls

and Suppi's pair was already on their way home on 350 degrees. Buster had heard my calls because, as per him, as soon as he landed, he told people that "Khappe got the Sabre behind me". That is how I pieced this together to realise that I had missed seeing Lele's formation which had closed in on us ahead of their ToT since they were supposed to be 2 minutes or 14 nm behind us at tactical speeds but seeing the pair being fired at in the general area where I expected Suppi and Billoo to be, I had mistaken Buster's pair to be them.

Still, the narration on Lele's formation, as per the book, raises a number of questions. If Bajwa had seen the Sabres ahead engaged with us, why did the same Sabres turn up behind them in very short time ? Since they were in an ideal position of advantage to engage these two Sabres, why didn't they do so ? Also, Lele's decision to disengage despite advantage of position and fuel, since they had two minutes more fuel than us, and the other three members staying back to engage one of the Sabres, is not borne out by the fact that I saw Buster's pair being fired at



Painting by SMA Hussaini, official combat artist of the Pakistan Air Force, which depicts Flg Offr M Shamsul Haq of No.14 Squadron PAF shooting down one of the four IAF Su-7s attacking Tezgaon on 4 December 1971. In another painting, a Sabre is shown shooting down an IAF Hunter over Dacca in the evening of 4 December 1971, 'the last encounter'.



from right and Harish Masand is centre row 2nd from left. [Photo: Air Commodore KB Menon].

and there was no Sabre ahead of them. This pair was just turning loosely. After leaving Buster trailing alone in a stricken Hunter and struggling to get home also raises some questions. I think if Jagan or Samir had spoken to Buster or me, they would have got an accurate version of this engagement.

Similarly, in Chathrath's formation, Sqn Ldr TR Patel, attached from Training Command, was supposed to be No. 3 but had turned back from the border because of some problems with his aircraft, leaving 'Tricky Dick' Dixon and 'Dody' Bansal with Chathrath. As I heard, the Sabres spotted by Dixon were flying on a reciprocal course north while Chathrath's formation was heading south with Dixon on Chathrath's wing and Dody on their right abreast and thus closer to the Sabres. After the initial hard turn, when the Hunters and the Sabres crossed each other, Chathrath's decision to go after the lead Sabre could be questioned since he would have been sandwiched by the trail Sabre flying a mile behind the lead Sabre. If the hard turn brought the Hunters behind the Sabres, as the book narrates, the trail Sabre should have been closer to Chathrath and should have been

the obvious choice for the lead Hunter. From this position with the two Hunters behind the two Sabres, the book goes on in the very next paragraph to describe how the lead Sabre was performing skillful yo-yo's to get Chathrath in his sights indicating that the Sabre had the advantage of being in his rear quarter. Once again, without going into a detailed analysis of this encounter since I was not personally there, I think Jagan and Samir should have checked the story with Dixon and corroborated it with No.17 Sqn war records to get an accurate version of this combat.

Many such questions arise in most narration of combat engagements. These need further corroboration to make the story comprehensive and convincing even though the end results may remain the same. As just one example, 'Dadoo' Subaiya's cutting in front of the Sabre described on Page 121-122 is rather strange. The usual tactical action is to order a turn to the formation under attack while positioning oneself behind the attacker to shoot him down or at least force him to break off from the strike formation. Similarly, after Buzzy spotted the Sabre behind Dadoo (Page

123), himself being behind Dadoo and the Sabre, why didn't he follow the Sabre to threaten him and force him to break off the attack instead of having to call Dadoo for his position?

Actually, I don't blame the authors for such discrepancies in their compilation of combat engagements since they have little expertise in this area. I am only suggesting that they could have co-opted someone with air combat experience to speak to the participants and check records to make the narration more credible.

A clarification is also due on Sqn Ldr Samantha's loss on Page 144. I heard the story first hand. 'Skeja' Nair wanted to continue with Samantha to escort him to Agartala, but Samantha ordered him back to base taking chances in hostile airspace in a damaged Hunter, displaying rare and commendable degree of concern.

I am also of the opinion that the authors could have dwelled upon another aspect of whether the IAF utilised its assets optimally to achieve the objective of gaining air superiority in the most efficient manner. Such an analysis would have



Flt Lt Harish Masand at the Air Force Academy, circa 1974. The statue in the foyer of the main AFA building is modeled after him.

been useful to future generations of professionals and military historians. Why did the IAF choose to attack airfields in this manner, at low levels and extreme ranges, at times without any combat reserves, with limited and ineffective armament despite such overwhelming numerical and qualitative superiority? Could not the IAF have decided to send strike aircraft with bombs at medium to high altitudes with sufficient escorts from Day One to destroy the runways ? If the Sabres had chosen to intercept, the strike aircraft could have jettisoned their bomb load and joined the fight, resulting in numerical superiority. The IAF strike aircraft could have attacked airfields in steep dives, thus avoiding losses to anti-aircraft fire. A photo recce mission (with escorts) could have been launched timed after the first raid to assess damage caused as well as the location of Sabres on the ground. This would have helped in planning and executing subsequent raids more effectively. Also, raids could have been planned in a manner where all assets were not utilised in a single wave but in staggered manner giving little respite to the lone

Sabre squadron in Dacca. Such queries and analyses would have made the book more incisive.

Overall, I feel the narration in the book would have flowed more smoothly and made understanding easier if it was linked a little more with the ground war as it progressed in each sector with a reference map indicating the changing position of ground forces at each stage.

Notwithstanding all these observations, both Jagan and Samir must be complimented for their efforts in producing such a book on the air war, first of its kind, one of great use to those connected with air forces and military history, and even the lay reader of future generations. I personally enjoyed the book and learned about matters that I did not know of, even though I was an active participant in that war.

> The Indian Air Force in the 1971 Liberation War

EAGLES

OVER

BANGLADESH

P.V.S. JAGAN MOHAN

and

SAMIR CHOPRA



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Vayu Self AD

Review of the Exercises

C15-28

Frisian Flag 2014

Spanish Air Force Typhoon

rom 31 March to 11 April 2014, the annual 'Frisian Flag' exercise took place at Leeuwarden air base in the northern part of the Netherlands. During these two weeks, the participants executed a mix of air-to-air and air-to-ground air-war scenarios. Realistic international cooperation is one of the aims of this exercise, as the lessons learned from recent Afghanistan and Libya operations have shown. Many international operations are conducted by multinational taskforces, with

various aircraft types, different tactics, doctrines and training-levels, unfamiliar command-chains and diverse air-refueling procedures and certifications. Exercises like *Frisian Flag* provide low-cost training for multinational operations.

Offensive and defensive air-to-air sorties along with offensive and defensive air-toground sorties were conducted twice a day with as many as 40-50 aircraft airborne for each mission. As the exercise progressed, the



missions grew steadily more complex and demanding. Preparations for the morning missions were conducted the day before and ended with a mass briefing early in the morning, while the afternoon missions would commence with planning early in the morning and end with a mass briefing just before takeoff. All participating countries played the role of mission-commander' for mission and all countries could bring in their tactics, doctrines and lessons-learned from previous exercises and real-war experiences.

The Dutch Air Force 323 TACTESS (Tactical Training Evaluation and Standardisation) Squadron have organised the *Frisian Flag* exercises (and its predecessors) for over 20 years. The main task of 323 TACTESS Squadron is to standardise the Dutch operational F-16 tactics and doctrines.

All aircraft participating in *Frisian Flag* operated from Leeuwarden in the Netherlands, save for a single French E-3F AEW&C aircraft that joined the exercises from Avord air base in France. The participating aircraft included :

• Dutch F-16s from Leeuwarden AB and Volkel AB

- Belgian F-16s from Florennes AB
- Danish F-16s from Skrydstrup AB
- Norwegian F-16s from Orland AB
- Portuguese F-16s from Monte-Real AB
- Finnish F/A-18s from Rissala AB
- German Eurofighters from Noervenich AB and Neuburg AB
- Spanish Eurofighters from Moron AB
- Dutch C-130 from Eindhoven AB, acting as 'slow-mover'





- Civil aircraft in the Electronic Warfare role
- French E-3F from Avord AB (FR)

Cooperation with EART 14

In parallel with *Frisian Flag*, the '*European Air-to-Air Refueling Training*' exercise (EART 2014) was held for the first time this year, operating from Eindhoven airbase in the southern part of the Netherlands. (*see article in this issue*)

The European Defence Agency (EDA), together with the European Air Transport Command (EATC), organised EART with the aim of adding refueling training to the Frisian Flag exercise. Lessons learned from past international operations have revealed that European forces depended heavily on the aerial refueling capability of the USA, with only 40-odd tankers available in Europe, as opposed to over 500 tankers in the USA. In 2012, European nations committed to increasing available tanker capacity for the future and to improve and streamline current tanker operations. With the aim of reducing fragmentation and optimising current refueling assets, the EATC timed the first EARTexercise to coincide with Frisian Flag 2014. The EART involved training in coordinating RV procedures, multiple refueling formations, tactical refueling, cell procedures, bail-out and SAR procedures. In

addition, participating nations gained technical and operational refueling clearances with the Italian Air Force's new KC-767A tanker.

Speaking about the exercise, Giampaolo Lillo, EDA Director for Cooperation Planning & Support, commented, "this first European Air-to-Air Refueling training is a prime example of how Europe can optimise the use of its existing assets through multinational cooperation. The EDA has a role to play as an enabler, however the success of the training is thanks to the Netherlands as host nation, EATC, and the participating Member States."

During EART 2014, three tankers operated from Eindhoven AB:

- Dutch KDC-10 from Eindhoven AB
- German A310 MRTT from Köln-Bonn AB
- Italian KC-767A from Pratica di Mare AB

Participants Review

Through the exercise, interviews were held with the detachment commanders (DetCo) of various participating air forces. Despite hailing from different nations and operating varied aircraft, these officers had common views on the outcomes of *Frisian Flag* 2014.

A number of comparisons were drawn

with the American *Red Flag* international exercises held at Nellis AFB, Nevada. Western European weather was noted as a complicating factor that has to be taken into account during European exercises, compared to the clear flying weather that is experienced year-round in Nevada. Additionally, some personnel noted that during *Red Flag*, live flares are allowed to be dispensed over the deserted practice areas, whereas their use is restricted over Europe.

E-16s in formation

On the other hand, the DetCos were unanimous in expressing pleasure that a large multinational, multi-aircraft and complex exercise such as Frisian Flag is held in close proximity to their home bases, reducing the complexity of logistics, and allowing for training to be conducted at a lower cost! Compared to the Red Flag exercises in the United States, for instance, a lot less transport has to be arranged and spare parts as well as spare aircraft (if necessary) can be accessed almost effortlessly. Another major advantage of Frisian Flag is the participation of European countries operating under European rules, whereas Red Flag exercises are conducted following American air warfare doctrines.

Joris van Boven/Sentry Aviation News Harold van Eupen/Sentry Aviation News Refueling Together!

Dutch KDC-10

an Fla

P rom 28 March until 11 April 2014, the first ever multinational '*European Air-to-Air Refueling Training*' exercise, abbreviated as 'EART 2014,' was held under the auspices of the European Air Transport Command (EATC), based at Eindhoven in the Netherlands. Daily morning and afternoon missions were flown by the participating tankers in support of the Dutch international fighter exercise '*Frisian Flag*' (*see article in this issue*) being held in tandem with EART 2014, in order to meet the goals set by the EART organisation.

EATC

With Governments worldwide reducing defence expenditures, four European countries (The Netherlands, Belgium, Germany and France) put together a new command when the EATC was inaugurated at Eindhoven on 1 September 2010. The objective behind this multinational concept was to cut costs by pooling and sharing national military air assets. The four members of the EATC have put major parts of their air transport and airto-air refueling fleet under the operational



control (OPCON) of the EATC. At the moment the missions of almost 150 aircraft are planned, tasked and controlled out of Eindhoven. Owing to its successes, Luxembourg (although without aircraft) officially joined the EATC on the 22nd November 2013, with Spain and Italy both set to join the organisation by summer of 2014 and early 2015 respectively. Other countries, such as the UK, have also shown interest in the concept.

Initiative

In military aviation, exchanges and exercises between squadrons are well known within the fighter community and the last few years have also seen a growth in competitions between military transport units. On an European Defence Agency (EDA) initiative, the EATC organised an air-toair refueling (AAR) dedicated training environment, using the opportunities to support one of the largest European fighter exercises, Frisian Flag, which was held simultaneously with the EART training. This was probably the first dedicated AAR training ever held over Europe. The EATC also encouraged air forces from outside the EATC organisation, to join with their tanker capabilities in order to participate in this training event. The Dutch Air Force's Major Fröhlich, exercise director and KDC-10 pilot with 334 Squadron explains why: "European AAR capacity is characterised by an important shortfall (80% of AAR refueling sorties during the Libyan war in 2011 were flown by US assets) and next to this fleet fragmentation is resulting in reduced overall efficiency (both from an



operational and cost point of view). This training was an excellent opportunity within Europe to operate with dedicated AAR scenarios embedded in a highly recognised fighter exercise. Next to this we also set some other goals, after input from the participants, which are not practiced on a common day to day mission, like tanker rendezvous training."

Participation

During Operation Unified Protector (OUP) over Libya in 2011, one of the lessons learnt was the lack of dedicated AAR focused exercises where both tanker and logistics crew can familiarise with explicit scenarios, but also - more importantly keep them proficient in areas other than what is practiced during daily (local) AAR operations. The Netherlands joined EART 2014 with one KDC-10 of 334 Squadron from home base Eindhoven, the German Air Force sent an A310 MRTT of the Flugbereitschaf des Bundesministeriums der Verteidigung (FBS BMVg) from Köln-Bonn air base and Italy, although not a full EATC member yet, participated in the second week of the training with one of their recently acquired KC-767A from 8° Gruppo (8th Squadron) of the 14° Stormo (14th Wing) based at Pratica di Mare. EATC member nation France could not join due to ongoing efforts in Operation Serval in Mali, Africa and therefore had to cancel their tanker (C-135FR) presence for the EART exercise.

Italy

Joining the EATC as the sixth member by early 2015, the Italian Air Force immediately showed interest to join this multinational training exercise. This was for more than one reason, according to Maj Rossi, detachment commander (DetCo) of the Italian Air Force 14° *Stormo*/8° *Gruppo* at Eindhoven air base: "First of all we want to show our allied partners our new KC-767A aircraft. It was declared Final Operational Capability (FOC) with our squadron only in late 2012. The aircraft has not been seen abroad a lot, especially in conjunction with exercises. Secondly, we had the opportunity to build up our experience with fighter aircraft from nations we normally do not train with a lot or at all. Our aircraft is equipped with both the boom as well as the drogue system so perfect for all players of *Frisian Flag*. But unfortunately owing to not achieving technical and operational certifications with all the participating countries in the *Frisian Flag* exercise on time, we were only allowed to refuel the Spanish Eurofighters during EART 2014."

The Italian detachment comprised of twenty-three persons of which five were pilots, two boom/drogue operators, ten aircraft technicians and six support



personnel, joining the exercise only at the second week due to the aforementioned certification issues they still flew six missions, refueling a total of twenty-four aircraft.

Eindhoven

As Eindhoven air base is the home of both the Dutch KDC-10 tanker fleet (334 Squadron) as well as the EATC, the organisation requested use of Eindhoven air base as the Tanker Forward Operating Base (FOB) during EART 2014, which was approved by the Dutch Ministry of Defence. With Eindhoven air base as FOB during the training campaign the organisation had some advantages at hand as told by the exercise director Major Fröhlich: "One advantage is that by providing multiple cross-servicing training opportunities and the local (334 Squadron) AAR Air Operations Centre it enables joint tanker crew briefing premises and therewith an overall easy exchange of tanker crew training and operational experience. Second advantage is that with a flying time of about 20 minutes to the exercise area of Frisian Flag (to the North of the Netherlands) it saves on transfer time and therefore is cost effective. A third advantage was that a local area network was available daily to keep in close contact with the Frisian Flag exercise at Leeuwarden air base. In this way the tanker crews were able to receive their air tasking order (ATO) and other relevant information

(like maps and the communications plan) for next day missions, be informed about the exercise scenario and updates if necessary and the progress of this scenario during the course of the exercise."

Objectives

For EART 2014 a couple of objectives were set. One of the first and most important objectives was to plan, brief, execute and debrief multinational tanker training and tanker operations in large scale Combined Air Operations (COMAO) packages in a realistic scenario. The scenario used was that of the parallel *Frisian Flag* exercise with over 40 fighters participating in each of the two waves per day. Therefore all participating tankers units had ample opportunity to plan, execute and debrief missions and to reach this objective. A second, much less common objective was tanker-to-tanker rendezvous procedures. During this twoweek exercise a few occasions were utilised to practice this. A third goal was to train both aircrew and logistics personnel in quick turnaround procedures and execution. With the tankers landing at Eindhoven at the end of the morning after first mission of the day





and departing again about an hour and a half later, flexibility and speed were required by all personnel. Judging by the fact that all take off times were met, one can only conclude that this goal was reached.

Hooking up

One of the key objectives next to the regular fighter refueling task during *Frisian Flag* was the training of tanker rendezvous procedures. In common practice tankers are mainly used for (local) fighter refueling to ensure proficiency for tanker crews and fighter pilots. But sometimes the fighters

refuel with each other the procedures of approaching and departing the tanker were rehearsed so everybody involved got some valuable training on this aspect. You have to calculate the timing of the turns and speed according to the actual situation and flight level you are operating. Challenging, in the way that you have to do a quick calculation with multiple variables and time pressure."

Success

According to Major Fröhlich of the EART organisation, all objectives were met with only a few missions cancelled, mainly due multiple tankers stacked above each other during the refueling of fighters like it was also used in the Libyan war of 2011. Also the rendezvous training was very useful although our unit hardly ever uses it. It is good to train in NATO procedures for when the situation arises."

With the EATC based at Eindhoven as well as the support given by the local based tanker unit, operational lines were short and participants commented on the professionalism, support and value of the exercise. All participants went home satisfied with new experiences and friends.



are traded in for larger aircraft like other tankers, E-3 AWACS or C-17s. These aircraft have very different flying characteristics in comparison with fighter aircraft as explained by Major Hacket, DetCo of the German A310 MRTT: "Fighter aircraft when hooked up to the drogue or boom system can be very flexible when situations during refueling change, for example during sudden turbulence. Larger transport or tanker aircraft are not that flexible. Therefore we utilised this exercise to train these routines with each other. Although we did not actually to fog conditions at Leeuwarden air base in the first week resulting in the cancellation of the *Frisian Flag* wave. According to the feedback given throughout the exercise, all participating units found the training in combination with support to the *Frisian Flag* exercise very useful and well chosen. Major Hacket summarises: "We would have liked to send some of our younger pilots and drogue operators but they were not mission ready yet. This training would have given them a perfect opportunity to learn to operate with Whether this means that more (frequent) tanker-dedicated exercises will be held in the future remains to been seen. Maybe next year again at Eindhoven air base supporting *Frisian Flag* 2015 and possibly with more tankers, for example from EATC members France and Spain. But also non-EATC members like the UK and the USA are invited to join to learn from and with each other!

Remco Stalenhoef Patrick Smitshoek Stephan van Geem

Ancient Aviator Anecdote





y generation of young men, who in the aftermath of Independence Joined the flying branch of the air force, did our pilot training on noisy propeller–driven aircraft where the pilot(s) were seated just behind the aero engine. Post graduation we went on to fly even more deafening piston engined fighter and transport aircraft of World War II vintage. The induction of jet aircraft in the early 1950s reduced the decibel level in the sealed cockpit somewhat as the engine was now located behind the pilot. However, the ear splitting whine of the jet engine was harmful for the ground crew, so ear defenders were procured for technicians on the tarmac. We were of course fit, keen and active young fliers but were yet to understand the meaning of 'sound pollution' or assess its long term effects on the sense of hearing.

As we progressed on to more powerful and faster combat aircraft, we were introduced to the 'sound barrier' and taught how to break it. For safety purposes, this training exercise was carried out at a very high altitude. In some ways, the actual experience was a bit disappointing as only one instrument in the cockpit (ie, the Mach meter) indicated that one was now flying faster than sound; the pilot himself hears nothing as he goes through the famed sound barrier. One was thereafter presented with a certificate of membership in the *Mach Busters Club* !

Active fliers spend most of their air force careers working and living on military airfields and thus continue to be exposed to high levels of noise generated by the operation of aircraft day and night. The resulting reduction in hearing levels is very gradual and not significant enough to show up in the annual medical examinations. Owing to a disciplined life style, most aircrew remain fully fit throughout their flying careers. In 1980, while on duty as an Air Commodore in the UK, I was authorised to fly four familiarisation sorties on the Hawk jet trainer aircraft as a possible induction into our air force. That it took 25 years to do so is another story! During the pre-flight medical check, the doctor did mention a slight loss

of hearing in one ear. It in no way affected my flying but was likely to do so in the years to come. He then introduced me to a tiny little gadget called a hearing aid!

Post retirement and in my 70s, I was fitted with a hearing aid in each ear, one click of which ensured adequate audibility. Due to population growth, voluminous traffic and other high decibel activities (especially in urban areas) we now live in a much more noisy world than my generation was born into. At a recent reunion of my coursemates (all of us octogenarians) I was comforted to observe that nearly all of them were also sporting the tiny little 'add-on'! We of course philosophied that impaired hearing was only Nature's way of protecting air veterans from noise! Pleading 'deafness' was also a plausible defence when confronted with complaints from the wife who undoubtedly continues to be the most reliable hearing aide ! The electronic hearing aid has broken the sound barrier by providing an option to hear when required, or to retreat into the peaceful sound of silence, when not !

Air Vice Marshal Cecil Parker (retd.)

Years Back

First A320s for Indian Airlines

The initial two Airbus A320 aircraft for Indian Airlines are expected to be handed over in June 1989 and will be followed by batches of 3 to 4 aircraft each month till all nineteen A320s on order are delivered by March 1990. To tide over the current shortage in capacity, IA have leased nine aircraft comprising two A300s, five Boeing 737s, one Tu-154 and one BAe 146-100 (time charter) while another Boeing 737, all II-62M and one Tu-154 are proposed to be leased.

IAF Squadron trophies

Selected Indian Air Force squadrons were presented trophies for "excellence in service" at the recent Commander's Conference in New Delhi on 11 April. The Flight Safety Trophy for supersonic fighters was presented to No.5 Squadron, for transonic fighters to No.22 Squadron, for transport aircraft to No.33 Squadron, for helicopters to No.129 H.U., for Flying Training Establishments to the Air Force Station Bidar, while the Maintenance Trophy has gone to No.35 Wing.

Jetliner production by HAL ?

The Planning Commission has constituted a Committee to work on the feasibility of Hindustan Aeronautics Limited undertaking manufacture of commercial aircraft. Meanwhile HAL has been visited by representatives from both Boeing and Airbus Industrie, who examined the feasibility of component production at the various divisions of HAL. In late-April, a 13-member Soviet team from the Yakolev design bureau were visiting India to discuss possibilities of the production of the Yak-42 by HAL, albeit with some modifications. There have been earlier visits from the Tupolev and Ilyushin plants as well and the possibility of Tupolev 204s with some Western avionics and equipment, including cabin furnishing, being assembled by HAL is one option under discussion.

Indigenous aircraft carrier

Construction work on the first indigenous aircraft carrier for the Indian Navy would commence at the Cochin Shipyard within two years, according to the CNS, Admiral JG Nadkarni. Construction would be entrusted to the Cochin Shipyard who had hitherto only been involved with building of smaller warships and survey ships for the Navy. The new aircraft carrier is expected to be commissioned by 1997.

Indian Army Air Corps

Twenty two army officers, all from the Armoured Corps, who had attended the Basic Army Aviation Course with the Air Operations Squadron were presented their wings at a recent ceremony at

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Gandhinagar. Meanwhile, the Army Ordnance Corps is to take over responsibility for the maintenance and overhaul of the Chetak and Cheetah helicopters of the Army's Aviation Wing, hitherto handled by the IAF since the Aviation Corps was established in November 1986. Over the hundred utility and observation helicopters were involved in the transfer from the IAF to the Army nearly three years ago but the IAF were to remain responsible for technical support and maintenance till late 1989.

Additional F-16s for Pakistan

The Bush Administration is yet to take a decision on Pakistan's request for 60 more F-16 fighters, but official testimony before the House of Committee on Asia and Pacific Affairs show that Washington is leaning towards acceding to the request. The Pakistan Prime Minister Ms Benazir Bhutto, has expressed to the US Ambassador her full support to the modernisation of the Pakistan Air Force including the procurement of 60 F-16s as proposed by the erstwhile Zia regime, the Committee was told. Pakistan would meet the cost, expected to be about \$ 1.2 billion, from its own funds without drawing on the US credit to be provided under its aid programme.

Discussing the effect of the F-16 sales on the military balance in the region, Mr Gnehm said : "There is no question that the Indian Air Force is much larger and has a superiority no other country in the region has. Even with the additional F-16s, Pakistan will have nothing in their inventory that equals the advance striking capability of, for instance, the Indian Jaguars".

China expands Army Air Corps

The People's Liberation Army (PLA) have placed an order for six Boeing CH-47D Chinook heavy lift helicopters for its newly formed Air Corps. Expected to enter service in the early '90s, the Chinook's will be a major addition to the PLA Air Corps which was established in 1988, enabling the heli-lift of field artillery and rapid deployment of troops. The helicopters will be equipped with three external cargo hooks and have a maximum single-hook capacity of 28,000 lb. The demonstrator Chinook helicopter was airlifted to Tibet by a US Air Force C-5 Galaxy for a series of extended hot-and-high performance tests in the high mountainous region, bordering India, Nepal and Pakistan. The Chinook reportedly "completed all assigned tasks successfully". The PLA Air Corps headquarters are at Tong Xian, some 18 km, east of Beijing.

Australian Mirage IIIOs for PAF?

The Australian government has reportedly rejected bids by Pakistan and France for the purchase of 50 ex-Royal Australian Air Force Mirage IIIO fighter aircraft as neither offer was considered adequate in view of "the condition for the fighters and the extensive spares and tooling which will accompany them. The Pakistani offer was also qualified by unacceptable financing terms".

Ab ki baar, Modi Sarkar !



(Contributed by Parikshit Mehra)

Why No.7 is No.1



In a survey carried out by mathematicians in England, SEVEN has turned out internationally to be the favourite single digit. 'Seven' is a number famously linked with the deadly sins, Snow White's dwarves and David Beckham's football shirt, but according to the majority, seven is the number of stellar objects in the solar system, seven is the number of chakras, seven is sunday ... seven just feels magical !

For enthusiasts of the Indian Air Force, No.7 Squadron is also a favourite ! In pecking order of establishment it is well behind No.1 Squadron but the latter actually 'disappeared' from the IAF's order of battle in August 1947 even as the Battle Axes of No.7 Squadron went into action a few months later, becoming heroes of the battle of Shelatang. Both Squadrons currently fly the Mirage 2000.

Shrimp cocktail

Tale Spi

Scientists have designed a composite material, inspired by *mantis shrimp*, that is more impact resistant and tougher than the standard material used in construction of aircraft. The material could also be used in making aerospace and automotive frames, body armour and football helmets. The peacock mantis shrimp, or stomatopod, is a 4- to 6-inch-long rainbowcoloured crustacean with a fist-like club that accelerates underwater faster than a 22-calibre bullet. Researchers from the University of California, are interested in the club because it can strike prey thousands of times without breaking. The force created by the impact of the *mantis shrimp's* club is over 1,000 times its own weight.



Composites with this design structure could well be used in aerospace programmes.

When the Saints go marching out !

As Dilip Bobb wrote on 17 May : AKAntony can now join the church and become a priest, since he was always known as St Antony, while Manmohan Singh will remain a great success in treating of insomniacs !

The power of nature



This picture is worth a trillion volts. Lightning illuminates a cumulonimbus cloud over Corio Bay in Victoria (photographed by James Collie). Advisory to pilots : stay on ground till this settles !

Advertisement which appeared in national newspapers on 16 May 2014, the day results of the national election were announced. Complete coincidence?



Air India Anto-Africa Deservation Constraints in Hammand and Arter Term Africanes, AMT an enternable return Deservation (333,907)-, allow hitter Serversion Deservations





(Contributed by Lalit Mehra)



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