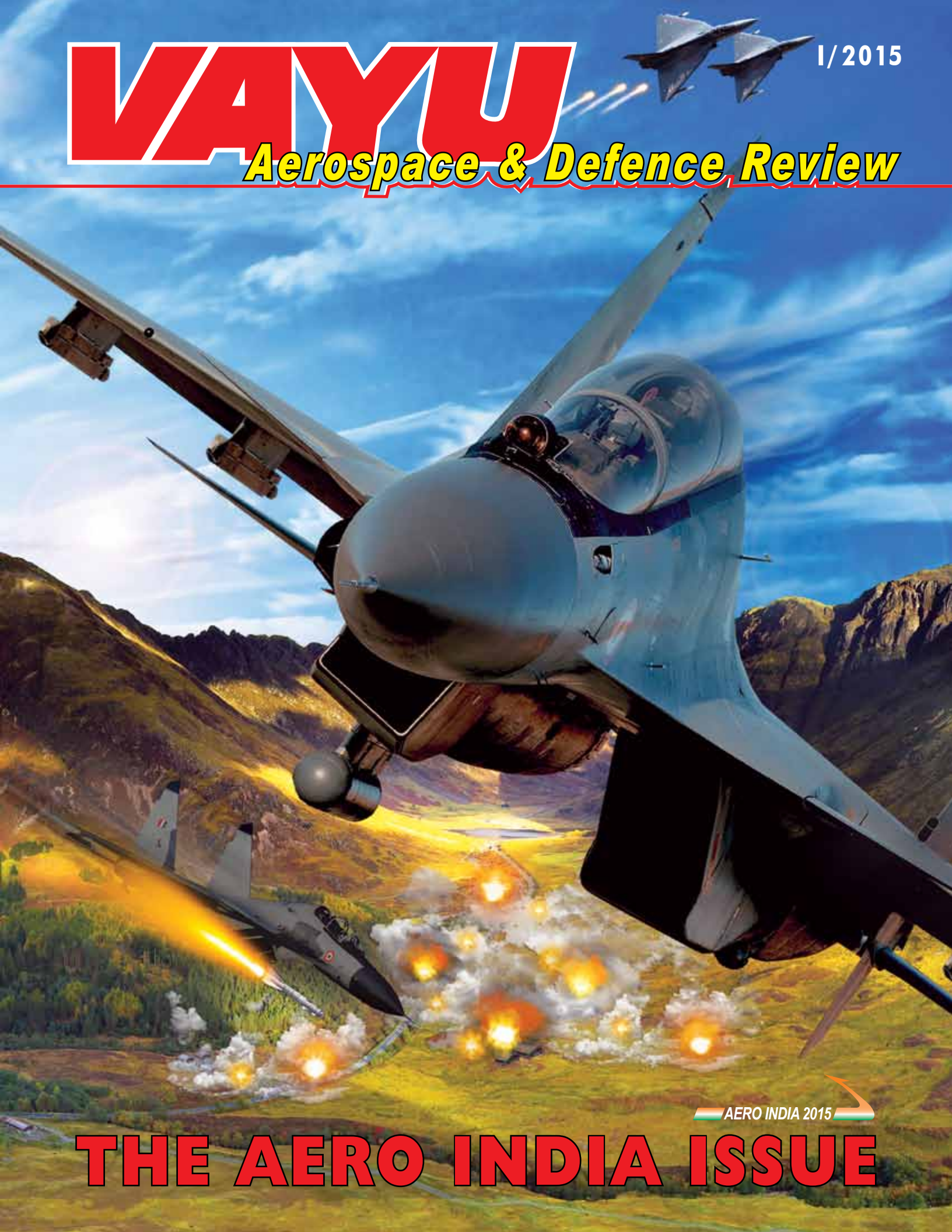
VAYU

Aerospace & Defence Review

I/2015



AERO INDIA 2015

THE AERO INDIA ISSUE

Safran

Artist's impression of IAF Su-30MKIs conducting an air strike as a pair of Tejas LCAs provide top cover. The Su-30MKI is the IAF's primary combat aircraft, while the Tejas LCA has recently been accepted into service. Both aircraft types are on display at Aero India 2015 (Digital art by Priyanka Joshi)

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VAYU DPS

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Ready For Take-off

To ring in the new year on a note of good cheer, consider this: crude oil prices have plunged 45% relative to where they were this time last year. It's not just that there's a glut of oil in the market; commodity prices, in general, are falling, which should benefit a net commodity importer like India. That contributes to the other bit of good news: in January last year, the India story had gone completely off the rails. Let alone foreigners, even Indian businessmen were fleeing India and pursuing greener pastures abroad. But India is grabbing global attention again and could eclipse China in terms of growth rates if it plays its cards right in terms of productivity-enhancing reforms this year.

And many are willing to bet it will. In momentous Lok Sabha elections held in April and May last year India elected, at long last, a stable single-party majority government not dependent on volatile coalition partners and therefore having the capability, at least, to generate consensus on critical issues that's needed to move forward. We may not have seen much of that on the ground so far despite the pro-growth and pro-business intent expressed by the NDA government. But Prime Minister Narendra Modi has transformed at least the field of foreign policy with whirlwind tours and out-of-the-box initiatives.

This has served the purpose of raising India's global profile as well as mobilising India's diaspora on its behalf, strategies similar to those successfully followed by China. Also inflation is trending downwards at long last, which should give RBI room to cut rates. All of this should help break the low-growth rut in which the economy has been stuck for a long time.

Declining oil prices have other beneficial effects easing India's international environment. For example, they will take the edge off confrontation between Russia and the West over Ukraine. Since Russia depends on oil, President Putin will be forced to negotiate. That the Cold War is not returning is good news for India, as it doesn't want to be in a situation where it has to choose between friends. The political class, which likes to wallow in negative sentiment, should realise that tailwinds are behind us and learn habits of greater cooperation. 2015 can be India's year when it begins to break out and realise its true potential.

From *The Times of India*

Pragmatic Parrikar

Defence procurement in the country has been hobbled by charges of corruption and of illegal commissions pocketed by middlemen. It became a political storm with the Bofors' Rs. 64-crore kickbacks story with Rajiv Gandhi losing the 1989 election. Ever since, arms purchases had become hot potatoes as it were. The *Tehelka* sting operation about payments to politicians and army personnel in 2001 had led the then defence minister Jaswant Singh in the NDA government to set up a committee under BG Verghese to evolve a clear defence procurement policy (DPP). Thirteen years later, Singh's successor in NDA-II, Manohar Parrikar, has revealed that a new DPP will be announced soon.

Parrikar has also indicated that arms agents (he uses the term 'technical representatives') will be allowed to participate in the process of purchases. Ministry sources, according to agency reports, have said that these technical experts will be allowed a fee but no commissions or bonus on the purchases. It is easy to quibble over the terms and argue that middlemen in arms deals are being allowed in through the back door. But the need to be less rigid and more practical in these matters is dictated by the exigency that critical arms acquisitions are getting unduly delayed because of the controversies created around major arms purchases.

As part of this new pragmatic approach, the minister has allowed public sector unit, Bharat Earth Movers Limited (BEML) to supply spare parts to Tatra trucks which involved partially lifting the ban against Tatra. UPA-II had imposed the ban after the then army chief and now minister of state for north-eastern affairs, VK Singh, claimed that Tatra offered a bribe to him. Parrikar has found a technical way out of the impasse saying that it was Tatra UK, a subsidiary of the mother company, which was banned and there is no restriction in dealing with the other units of the company. Again, it is possible to criticise him saying that this is but a fig leaf. It has been found that Tatra trucks are crucial for the army and it is to deal with this pressing need that the ban has been partially lifted.

Parrikar's pragmatic approach is free of his party's shrill rhetoric against corruption when it was in opposition, and his willingness to take decisions based on the country's security needs. He is not taking the rigid position that any company which has been blacklisted will always remain on the list. He has given enough indications that there will be a review of those decisions. As a matter of fact, this makes a lot of sense because an erring foreign arms company should be penalised for breaking rules, and the penalties imposed should be punitive so that giving and taking of bribes will become counterproductive. It should not be kept away if its wares are crucial for the armed forces.

Prime Minister Narendra Modi's plan to make India an arms manufacturing hub will take time to take root and become a reality. In the meanwhile, there is no escape from making huge defence purchases from foreign companies. The need then is to establish these purchases on a firm and clear footing. There is need for an open debate on the issue of arms agents and the commissions they get paid by the companies they represent. Ways have to be found to prevent the commission amount being factored into the final price.

From *DNA*

Favourite Punching Bag

For some reason, DRDO has turned the favourite punching bag of all and sundry in recent times. The organisation has been slammed for cost and time overruns, for not excelling in design and development of advanced weapons and systems required by the armed forces, and of course for not planning

IRKUT

the line of succession both at the top and in selection of directors of different laboratories.

It is true that several projects are delayed, some even beyond acceptable limits, but one must understand that defence projects are never accomplished on time even in countries like the United States because the technologies involved are extremely complex. Besides, nobody acknowledges the fact that the organisation lacks the support of indigenous industry when it comes to sourcing certain devices, components, and subsystems for some of its projects, and therefore has to develop them because advanced countries are not ready to part with them.

Despite denial of technology and critical components and subsystems, the DRDO has managed to design and fly the Tejas, the light combat aircraft, which has logged more than 3,000 hours of flying without a single snag. The same is the case with sonar systems, radars and communication systems. And yet, some people ask why other organisations are doing well, and DRDO has no achievements to talk of.

First and foremost, the organisation must address the task of not just attracting the best talent but retaining them with incentives and provide opportunities to constantly interface with the academia. It means the HR department should become thoroughly professional, and not restrict itself to recruitment but also expand its scope of activity so that the talent available is harnessed to cater to the vast canvas encompassing more than 50 laboratories.

In every laboratory, two or three talented engineers must be identified, mentored and sent to IIMs for training so that they do not lack leadership qualities in case they are chosen to head the facility. And, most important, the most technically qualified engineer need not head the facility because he might not be the best person to manage manpower, and encourage his colleagues to get the results.

With retention of talent proving a daunting task in recent days, incentives should be announced for pioneering work, and opportunities to go on a sabbatical and work in academic institutes so that they not only get an opportunity to pursue a doctoral degree but also interact with the best brains in the field.

Simultaneously, experts in academic institutions should be allowed to work on projects in DRDO's laboratories for a year or two. Such a cross-flow will help the organisation address technological challenges quickly, and even overcome technological denials. It will help if the organisation allows lateral entry of experts, particularly those who are keen to return from advanced countries or from the academia, as otherwise futuristic technology could prove to be out of reach.

And, to provide young engineers opportunities to head a laboratory, the retirement age should be fixed at 63 with no extension in service as even one instance of extension will send a wrong signal to those down the hierarchy. If those in academic institutions are allowed to retire at 65, engineers in DRDO should continue till they are 63 rather than sign off at 60.

Lastly, to steer clear of criticism over delays, every laboratory should not set the timeframe for projects in the beginning but only after technology readiness evaluation, and announce a realistic date of completion after a mid-course review as this exercise will help take into account the availability of components and sub-systems in the country, as also complexities of technology.

Also, directors of laboratories should be empowered to acquire components or devices from abroad rather than run to the headquarters for approval, and await the outcome of a long-drawn process. To sum up, a couple of changes will help DRDO excel in a very short time.

Dr VK Aatre, former DG DRDO
From *The Asian Age*

Aerial Ancestors of Air India

If the conclusions of the 102nd annual Indian Science Congress, held in Mumbai recently are to be believed there is really nothing new under the Indian sun, not even Prime Minister Narendra Modi's 'Make in India' campaign, which seeks to project the country as an international manufacturing hub of all manner of products, from automobiles to defence equipment.

According to several of the participants in the science meet, ancient India was famed for its inventive and productive prowess, which included the making of nuclear missiles and rocket ships.

One of the scholarly papers presented at the conference described, in painstaking detail, how 7,000 years ago Maharshi Bhardwaj had knowledge of "aeroplanes which travel from one country to another, one continent to another, and one planet to another". This early aerial ancestor of Air India presumably did not suffer from the union problems that continue to beset its descendant. Moreover, ancient India's aviation industry was far superior to anything currently conceived by the likes of Boeing and Lockheed. For while today only a hundred principles of aeronautics are known to us, millennia-old Sanskrit texts list no fewer than 500 such principles.

There seems to be no end to the variety of ancient India's inventiveness. Apart from the precursors of ISRO's Mars mission which flew from planet to planet with the greatest of ease, the India of the distant past had mastered all manner of advanced surgery, including trans-species organ transplants, as evidenced by Ganesha, the elephant-headed god who has become our national good luck mascot.

Apart from having invented the zero, ancient India made other milestone contributions to mathematics. According to Union minister Harsh Vardhan, Indian scientists discovered the geometric theorem which they graciously permitted a Greek called Pythagoras to patent as his own. Similarly, the minister added, Indian mathematicians invented algebra, but "very selflessly" allowed the Arabs to lay claim to it.

Indeed, further research might well reveal that a lot of trademarked products and services currently in use in the West and other parts of the so-called developed world were actually invented in India's long-forgotten past. Google? Facebook? Twitter? You name it, chances are ancient India invented it. And perhaps the greatest invention that India can lay claim to is invention itself. 'Make in India' is fine. But 'Make up in India' — as in make up inventions — is even better.

From *The Times of India*

UTC

A 'Galle-ing' experience

Admiral Arun Prakash, former CNS, gives his opinion that instead of merely moaning about China's 'string of pearls' and 'maritime silk route' strategies, India needs to craft creative, dynamic and long-term maritime alternatives.

26 December 2004, a Sunday morning, saw the calm in Naval Headquarters (NHQ) being shattered by ominous reports of powerful seismic shocks and giant tidal surges in our Bay of Bengal islands and coastal areas. As the first Indian Navy (IN) warships and aircraft were being despatched on relief missions, appeals for assistance started coming from Sri Lanka and the Maldives. Having assigned resources to cope with the domestic emergency, NHQ considered it equally imperative to rush aid to the stricken neighbours.

Given the languid functioning of our bureaucracy, a proposal of this nature could have taken weeks or months to be processed by the ministries of defence, external affairs and finance. To one's utter amazement, the national security adviser (NSA) accorded instant approval on the phone, with the words, "We will sort out the paperwork on Monday". Eighteen hours later, citizens of Galle on the southern tip of Sri Lanka awoke to see Indian warships, laden with relief material, anchored off the devastated harbour.

ROLLS-ROYCE

Fast-forward to 1 December 2014, a decade later. I arrive in this picturesque port town for the *Galle Dialogue*, to be told by a Sri Lankan admiral, "People in Galle remember the tsunami. If you tell shopkeepers that you are from the IN, they will not let you pay !"

Initiated by the Sri Lankan ministry of defence in 2010, the annual Galle Dialogue has gained in significance and momentum with 38 nations, spanning the full alphabet from Australia to Zambia, represented at its fifth edition. India was given due prominence and the printed programme showed Dr Ajit Doval, India's NSA, as guest of honour and keynote speaker, with the first two sessions being chaired by Indians; one of them being the vice chief of naval staff (VCNS).

The NSA's oration on regional maritime security issues was heard with rapt attention and drew applause as he, tactfully, mentioned the early contributions of Sri Lankan statesmen towards creating an Indian Ocean zone of peace. The anti-climax came when it was discovered that the Indian VCNS had not arrived on the expected flight. The hosts, too polite to pose awkward questions, quietly found a substitute to chair the session. The Galle Dialogue 2014, thus, saw participation by the commander of the Pakistan Fleet, the deputy Chief of Staff of the PLA Navy (PLAN) and a dozen other flag officers, but the IN invitee was absent, leaving many questions hanging in the air.

The whispered explanation, when it came, was on entirely predictable lines; apparently, an MoD functionary had turned down, at the last minute and for reasons unknown, the participation of the VCNS. One felt a sense of déjà vu because the all-powerful and non-accountable MoD bureaucracy has a known penchant for sitting on files till the 11th hour, and then whimsically approving or, more often, rejecting the proposal. It is in the latter context that a recent Indo-Sri Lankan diplomatic spat assumes significance.

During September-October 2014, Chinese submarines, accompanied by support vessels, docked in Colombo Port on two occasions. This peacetime transit and replenishment of a submarine was described, both by the Chinese and the Sri Lankan governments, as "common practice". According to media reports, India took umbrage and told Colombo that its actions were of "serious concern to India's national security."

However, a look at the past would show that the episode called for quiet diplomacy rather than public display of indignation. While Sri Lanka's victory over the LTTE owes much to many nations, including India, it was China's military support that stood out for scale and constancy. China maintained bonded warehouses in Galle which supplied arms and ammunition to Sri Lankan forces on demand. Beijing also provided heavy weaponry and fighters either directly or through a willing Pakistan.

In comparison, India's military aid to Sri Lanka was slow and sporadic. South Block remained hostage, not only to blackmail by Chennai but also to its own timidity, myopic vision and inertia. A saving grace was the camaraderie, at senior levels, of the Indian and Sri Lankan navies, which enabled them to reach out across Palk Strait in times of need. The IN tsunami-relief operation helped to strengthen bonds.

Today, China's role in transforming this island nation, through massive loans and creation of impressive infrastructure is undeniable. India, on the other hand, has been laggard in assisting Sri Lanka's development on a significant scale.

In the face of China's advance into the Indian Ocean, all that India has had to offer, so far, is the vapid nostrum of 'strategic restraint'. Moreover, the dissonance between the MEA, MoD and NHQ has often thwarted the navy's endeavours to create strong bonds with maritime neighbours. A peripatetic PM Modi is, now, giving strong indications that India's foreign policy may be acquiring a badly needed grand-strategic underpinning.

A practitioner of realpolitik, Sri Lanka is not above playing one neighbour against the other. But given its client status vis-à-vis China, it may not have had the option of denying entry to PLAN submarines. However, Sri Lanka must not allow itself to become China's pawn, in total disregard of neighbouring India's strategic interests.

Minister GL Peris, Defence Secretary Gotabaya Rajapaksa and Navy Chief Vice Admiral Jayantha Perera with Dr Ajit Kumar Doval at the Galle Dialogue 2014 international maritime conference at Galle.

Countries in our immediate neighbourhood, many of them island nations, seek maritime security; sometimes through direct naval presence, but more often through urgent requests for material aid, training assistance and advice. In this context, rushing supplies of water to the Maldives was a fine gesture, but setting up a desalination plant will win us far more goodwill.

Instead of merely moaning about China's "string of pearls" and "maritime silk route" strategies, India needs to craft creative, dynamic and long-term maritime alternatives, like employing its Navy as the potent "instrument of state policy" that it is meant to be.

PILATUS

President Barack Obama's India Visit: Key Areas of Agreement

US President Barack Obama made a second visit to India in his presidency during 25-27 January 2015. In their joint statement "*Sanjha Prayaas*, *SabkaVikaas*; *Shared Effort, Progress For All*", the US President and Indian PM Narendra Modi expounded on their vision for bilateral relations between the two nations. The breakthrough with regard to the controversial nuclear deal and the *Joint Strategic Vision for the Asia-Pacific and Indian Ocean Region* is considered as focal point of the joint statement released by the MEA. Some of the key announcements are highlighted:

President Barack Obama inspecting the combined Guard of Honour at Rashtrapati Bhawan on 25 January 2015

On Defence Technology

The Leaders acknowledged the need for the two-way defence engagement to include technology cooperation and collaboration, co-production and co-development. To this end, the President and the Prime Minister emphasised the ongoing importance of the *Defence Technology and Trade Initiative* (DTTI) in developing new areas of technology cooperation in the defence sector including through co-development and co-production and the Prime Minister welcomed the US Defence Department's establishment of a dedicated rapid reaction team focused exclusively on advancing the DTTI. The Leaders expressed confidence that continued the DTTI collaboration will yield additional joint projects in the near future."

Prime Minister Modi, speaking a day later at the India-US Business Summit, declared that the framework for defence cooperation between the US and India has been renewed for another ten years. The defence technology and trade initiative will also allow for joint development and production of new defence technology. With the Government's 'Make in India' campaign in full swing and an increase in FDI, the emphasis on defence cooperation is significant.

On Civil Nuclear Cooperation

Noting that the Contact Group set up in September 2014 to advance implementation of bilateral civil nuclear cooperation has met three times in December and January, the Leaders welcomed the understandings reached on the issues of civil nuclear liability and administrative arrangements for civil nuclear cooperation, and looked forward to US-built nuclear reactors contributing to India's energy security at the earliest."

On Maritime Security

Prime Minister Modi and President Obama expressed satisfaction over the efforts made by both countries to deepen cooperation in the field of maritime security, as reflected in the 2015 Framework for the US-India Defence Relationship. To this end, they agreed that the navies of both sides would continue discussions to identify specific areas for expanding maritime cooperation. They also reiterated their commitment to upgrading their bilateral naval exercise *Malabar*."

The document on *Joint Strategic Vision for the Asia-Pacific and Indian Ocean Region* emphasised that "Regional prosperity depends on security. We affirm the importance of safeguarding maritime security and ensuring freedom of navigation and over flight throughout the region, especially in the South China Sea."

On Civil Aviation

The Leaders recognised the robust public-private US-India civil aviation partnership and agreed to continue working together to identify emerging technologies and build a larger commercial engagement agenda through key events such as the 2015 U.S.-India Aviation Summit and demonstration of advanced US technologies."

"Reaffirming their commitment to safety and security of civil aviation, the United States and India will continue consultations between the Federal Aviation Administration (FAA) and the India Directorate General of Civil Aviation (DGCA) to ensure international safety standards set by the International Civil Aviation Organisation (ICAO), with the aim of restoring Category I status at the earliest possible time."

THALES

Tri-service flypast over Rajpath

Seen to believe ! US-origin Boeing P-8I flanked by Russian-origin MiG-29Ks, all of the Indian Navy

As the Chief Guest, President Barack Obama witnessed the Republic Day parade on 26 January 2015, climaxed as always by the flypast. This year's was unique, being the first time in a decade that aircraft from all three services flew over Rajpath on R-Day. The flypast began with helicopters: an 'Ensign' formation of four IAF Mi-17V5 helicopters trailing the Indian flag and ensigns of the three services led three Army Aviation Dhruv ALHs. After the marching and tableaux and dancing troupes had finished their show, three Mi-35 gunships flew over, followed by fixed-wing aircraft : three C-130J Super Hercules in 'Vic' formation, followed by the undoubted stars of the day, an Indian Navy P-8I flanked by a pair of Indian Navy MiG-29K fighters. The Naval trio was trailed by a similar IAF mixed formation, a single C-17 Globemaster III flanked by a pair of Su-30MKIs.

Sukhoi Su-30MKIs (photos by DPR MoD)

The fighter flypasts had two 5-aircraft 'arrowhead' formations: No. 5 Squadron 'Tuskers' Jaguars came in first, followed by five MiG-29s. The final formation flypast consisted of three Su-30MKIs, which conducted a 'Trishul' break in front of the reviewing dais as they trailed white smoke. The climatic single Su-30MKI streaked low and fast over Rajpath before conducting its signature 'Vertical Charlie' manoeuvre and disappearing into the sky.

G Mohan Kumar co-chairs DTTI

The Government of India nominated Secretary of Defence Production G Mohan Kumar to co-chair the Indo-US Defence Trade and Technology Initiative (DTTI), alongside US Under Secretary of Defence for Acquisition, Technology and Licencing, Frank Kendall.

Over the coming years, the Indian Armed Forces are considering procurement of some $8 billion worth of US defence products, including 145 howitzers from BAE Systems for about $700 million, 22 Boeing Apache AH-64E attack helicopters for $1.4 billion, 275 F-125 aircraft engines for Jaguars for about $2 billion, 50 F-404 aircraft engines for LCAs worth $250 million, four additional Boeing P-8I aircraft for $1 billion, 15 Boeing Chinook CH-47F heavy-lift helicopters for $1 billion, and six more Boeing C-17 transport aircraft for $2 billion.

Russian Defence Minister visits India

A week before Mr Obama's arrival in New Delhi, Russian Defence Minister Sergei Shoigu met with Indian Defence Minister Manohar Parrikar at which time they "re-affirmed their commitment to the long-standing friendship and cooperation in the area of Defence Cooperation" between the two nations. Defence cooperation with respect to ongoing projects was reviewed, and both sides decided to hold interactions regularly to adhere to deadlines.

Defence Ministers Manohar Parrikar and Sergei Shoigu

With regard to the Fifth Generation Fighter Aircraft (FGFA) Parrikar said, "We have decided to fast-track many of the issues," adding there was "apprehension" about the slow progress on construction of the aircraft. According to sources, discussions were also held on the Ka-226 light utility helicopter which has been offered for co-production in India.

The 'Make in India' policy was brought up where Russia's participation was requested. Parrikar said the government had invited Russian companies to come to India for other joint projects, specifically production of spare parts for Russian-origin military equipment in India, adding that the Indian Armed Forces had "substantial" Russian (and Soviet) military equipment in service, including heavy artillery, AFVs, warships, submarines and missiles. An agreement on Flight Safety Exchange Information has been signed which is critical considering that considerable numbers of Russian-origin fighters, helicopters and transport aircraft types are operated by the IAF and IN.

AIRBUS MILITARY (DS)

Revised Defence Procurement Policy (DPP)

Speaking at the 'Vibrant Gujarat' summit in Gandhinagar on 11 January, Defence Minister Manohar Parrikar stated that a revised Defence Procurement Policy (DPP), incorporating various changes, along with a clear priority on development of the domestic defence industry plus a faster acquisition process, would be issued "within three months". A draft of the changed policy is already under review prior to being sent to the Cabinet for approval. In addition, it is understood that the revised DPP will include provisions to encourage private sector participation in defence manufacturing.

The Defence Minister also stated that the government was open to reviewing all cases of 'blacklisted' defence firms and has already partially lifted a ban on Tatra trucks. He said the reforms are "in the interest of the armed forces" and that based on merit and necessity, the government can consider lifting bans or imposing reasonable restrictions, "after proper verification." The MoD is also preparing a new policy that will allow foreign defence companies to legally employ 'agents.'

Defence Minister on the MMRCA

Dassault Rafale B at Aero India 2013 (photo : Angad Singh)

In his first media meeting on eve of the New Year, Defence Minister Manohar Parrikar referred to delays experienced in the IAF's medium multirole combat aircraft (MMRCA) programme. For some time, there have been reports on issues including accountabilities at the production phase, with Dassault 'uncomfortable' with providing 'guarantees' for the performance of HAL as prime integrator in the project. In the first phase, 18 Rafales would be supplied to the IAF as 'fly aways' by Dassault followed by 108 to be produced by HAL in phased manner but the OEM has expressed reservations in this regard.

In his television interview on 12 January, the Defence Minister went further in stating that "should complications in the Rafale negotiations not be resolved", the Su-30MKI offered "a viable alternative", given that HAL is currently upgrading the fighter with advanced avionics and EW Systems. He continued, "Su-30 choice is always there : what I mean to say is upgrade the Su-30, make it more capable". On the Rafale, Mr Parrikar declined to reveal the actual costs but stated, "Whether it is Rs 40,000 crore, or Rs 50,000 crore or Rs 1 lakh-crore, we are speaking about 50 per cent of the capital budget of the defence services". He revealed having been in touch with his French counterpart Jean-Yves Le Drian and that India was awaiting an "empowered" delegation to resolve the imbroglio.

Mr Manohar Parrikar seen with Air Chief Marshal Arup Raha and Air Marshal SS Soman during his visit to AFS Hindan

DAC clears proposals worth Rs 4,444 crore

On 17 December 2014 the Defence Acquisition Council (DAC), chaired by Defence Minister Manohar Parrikar, approved proposals worth Rs 4,444 crore, but continued to defer any decision on the 'Avro replacement' programme which has been jointly proposed by Tata and Airbus. The partners have proposed the Airbus Defence & Space C-295 tactical transport aircraft, 16 of which would be procured directly from Airbus with the remaining 40 to be built by Tata at their Hyderabad facility. The DAC reportedly sought further elaboration on the requirement itself.

The DAC approved purchase of four helicopters for survey vessels at Rs 2,324 crore, cleared the upgradation of the mobile integrated electronic warfare system *Samyukta* at a cost of Rs 1,682 crore, authorised purchase of P-7 Heavy Drop parachute systems for Rs 402 crore, and gave a go-ahead to acquire engines worth Rs 36 crore for Coast Guard OPVs.

Indian Navy selects Sikorsky S-70B

Sikorsky's S-70B Seahawk has been selected by the Indian Navy to meet its Multi-Role Helicopter (MRH) requirement. Sikorsky's commercial bid was opened at the Ministry of Defence on 4 December ('Navy Day'), following which would be contractual negotiations for the procurement of 16 S-70Bs to the Indian Navy, with options on a further eight helicopters. The contract will also include a comprehensive logistics support and training programme. This type will finally replace the Indian Navy's long-serving Sea King fleet, for which the replacement programme has now been ongoing for a decade.

UAC

The Seahawks will be employed in the anti-submarine and anti-surface warfare roles, serving both from warships and land bases. Installed mission equipment will include a 360° maritime search radar, air-to-surface missiles, sonar and torpedoes. President of Sikorsky's defence business, Sam Mehta has said that company's offer to India would be similar to the teaming model used in the sale of 109 S-70s to Turkey. The Indian Navy's long term requirement involves more than 120 additional maritime helicopters.

First Series Production LCA handed over

On 17 January 2015, Defence Minister Manohar Parrikar formally handed over the first series production (SP-1) Tejas light combat aircraft to the Indian Air Force in a quiet ceremony at HAL Bangalore. Air Chief Marshal Arup Raha, Chief of the Air Staff received the aircraft documents from the Defence Minister in presence of HAL Chairman Dr RK Tyagi but unusually, attendance and coverage of the event was entirely restricted.

LCA LSP-4 (KH2014) flown by Gp Capt Suneet Krishna at the SP-1 handing over event at Bangalore (photo: HAL)

Tejas SP-1 (LA5001) flew for the first time on 1 October 2014 (*see Vayu* VI/2014), piloted by Air Commodore KA Muthana, but presently remains in the initial operational clearance (IOC) configuration. Final Operational Clearance (FOC) is not expected for at least another year while this variant of the aircraft is also without the latest electronic warfare suite, which was only recently integrated into one of the LCA development aircraft (*see item in this Issue*), mid-air refuelling and BVR capabilities, all of which are expected to be incorporated by the time FOC is achieved.

The Defence Minister, Air Chief, HAL Chairman and others at the LCA SP handing over (photo : HAL)

Speaking at the ceremony, the Defence Minister congratulated HAL and everyone involved in the project, but also called upon programme stakeholders to think "out of the box" to meet future time-line challenges by applying the right management tools. "Thrust should be given on research and technology by exploiting the existing knowledge base which companies like HAL have," he said. "Although one does not achieve everything overnight. However by modifying our work culture and by adopting better technology and tools we can achieve the results better."

The Air Chief pointed out that the LCA is "need of the hour," given the IAF's operational requirements, and said he looked forward to commissioning of the first Tejas squadron (reportedly No.45). HAL Chairman Dr RK Tyagi called the historic event "one of the major milestones in history of HAL", however, he also admitting that the programme had achieved only "60% indigenisation" thus far. He committed to manufacturing six series-production standard aircraft in 2015, and subsequently scaling this up to 8 and then 16 aircraft per year.

N-LCA makes first ski-jump launch

On 20 December 2014 the sole LCA (Navy) prototype KHN-T-3001 (NP-1) successfully launched off the ski-jump at the Shore Based Test Facility (SBTF) at INS *Hansa*, Goa. This marked first time that the N-LCA was operated from the ski-jump of the SBTF, which replicates the deck layout of aircraft carrier INS *Vikramaditya*, as well as INS *Vikrant* (IAC-1), which is still under construction at Cochin Shipyard Limited.

Piloted by Commodore Jaideep Maolankar, Chief Test Pilot of the National Flight Test Centre, the aircraft reportedly had "a perfect flight, performing better than predicted." Dr Avinash Chander, then SA to RM, Secretary DDR&D and DG DRDO, congratulated the LCA Navy programme team after the launch.

EUROJET

Indigenous OBOGS and EW Suite for Tejas

An indigenously developed Integrated Life Support System (ILSS) based on the On-Board Oxygen Generating System (OBOGS), designed for the Tejas LCA was handed over by Dr VC Padaki, Director DEBEL (Defence Bio-medical and Electro-medical Laboratory) to Dr PS Subramaniam, Programme Director (Combat Aircraft) ADA on 29 December 2014. Also present at the ceremony were Dr K Tamilmani, DG Aeronautical Systems and Dr Manas K Mandal, DG Life Sciences *(see above)*.

Developed by DEBEL, the ILSS-OBOGS addresses the need for preventing in-flight hypoxia (oxygen deprivation) and 'G-force induced Loss Of Consciousness' (G-LOC) during high-G manoeuvres. Designed for the confined space available in the LCA, this OBOGS replaces the previous liquid oxygen (LOx) based system by utilising bleed air from the engine and separating oxygen by a process called Pressure Swing Adsorption (PSA). The OBOGS offers unlimited endurance unlike LOx systems that are limited by oxygen storage capacity. It also improves safety, reduces logistics and significantly lowers operational costs.

The ILSS-OBOGS will now undergo ground trials on the Tejas, followed by flight clearance, and the system can also be customised for other IAF fighters including the MiG-29, Su-30MKI and Mirage 2000.

Meanwhile, an advanced electronic warfare (EW) suite developed by the Defence Avionics Research Establishment (DARE), flew for the first time on board LCA PV-1 (KH2003) on 10 January 2015 at Bangalore. The equipment was "noted to be detecting radar emissions operating in and around the flight path during the test". In addition to a Radar Warning Receiver (RWR), the EW suite is also equipped with a self-protection jammer, which is capable of jamming radar threats detected by the RWR.

Mi-26 at new Kedarnath landing ground

An IAF Mi-26 heavy lift helicopter landed for the first time at Kedarnath in Uttarakhand on 6 January, the new landing ground built to facilitate swifter reconstruction of the town, which was devastated in mid-2013. The pace of rebuilding has been hampered by relative inaccessibility of the location, but establishment of this 'air bridge' will now allow hundreds of tonnes of equipment and material to be air transported swiftly to the area.

(photo : Nehru Institute of Mountaineering)

IAF flies potable water to the Maldives

In swift response to the national crisis faced by the Maldives following shutting down of desalination plants following a fire incident in the capital city of Malé, Indian Air Force transport aircraft flew to the Maldives with consignments of potable water to meet immediate needs of the population. Maldives, an island nation in the Indian Ocean, has no natural freshwater sources and relies entirely on treated seawater.

Indian Air Force C-17 at Male in the Maldives

Five aircraft were involved, including two C-17 Globemaster IIIs and three Il-76MDs which delivered 153 tonnes of water on 5 December 2014, while another three aircraft, two C-17s and one Il-76MD, flew in with 130 tonnes on 6 December. A third load of around 130 tonnes was delivered on 7 December.

Commissioning of CGAS 743

The Coast Guard's newest fixed-wing squadron, CGAS 743 operating HAL-Dornier 228s along with Air Enclave (CGAE) at Bhubaneswar were commissioned by Vice Admiral Anurag G Thapliyal, DGCG on 15 December 2014. CGAE Bhubaneswar is commanded by Commandant Rajeev Saini and 743 Squadron by Commandant Pradeep Sundriyal. The units will operate under the operational and administrative control of the Commander, Coast Guard Region (North East) through the Commander, Coast Guard District No. 7 (Odisha).

Coast Guard HAL-Dornier 228 at Chakeri, Kanpur where the type is built

RUSSIAN HELICOPTERS

CGAE Bhubaneswar was formally activated on 10 April 2013 and since then has been engaged in undertaking air surveillance in the area, augmenting Coast Guard operations along the northern Bay of Bengal with area of responsibility of over 150,000 sq km of the Indian Exclusive Economic Zone. CGAS 743 has started operations with two HAL-Dornier 228 maritime patrol aircraft.

HAL and IAF "are conjoined twins"

Air Chief Marshal Arup Raha and HAL Chairman Dr RK Tyagi stated that the Indian Air Force and HAL "are conjoined twins" and that "they will continue to complement each other" in India's defence preparedness. They were speaking at the 8th *Air Chief Marshal LM Katre Memorial lecture* at Bangalore on 29 November 2014 *(see picture)*.

Dr Tyagi stated that HAL was gearing up to emerge as a technology-driven company. "We have taken several measures on R&D such as ensuring funds to the tune of 10 % of profits, registering patents (430 plus at present) to protect intellectual property. We are contemplating developing aero-engines with the help of DRDO and BHEL," and added that "a platform for collaborative promotion and development of new and emerging technologies in the field of aerospace needs to be anchored around the technology roadmap of the Indian Air Force."

50 years of HAL Koraput

Speaking at the Golden Jubilee Celebrations of HAL's Koraput Division on 6 December 2014, Air Chief Marshal Arup Raha suggested that Koraput emerge as the 'aero engine capital of India.' The Air Chief inaugurated a two-day national seminar on 'Emerging trends in aero-engine architecture and self-reliance' as also an indigenisation and out-sourcing exhibition. The two-day seminar focused on topics such as advanced gas turbine engines for combat aircraft, developments in fourth and fifth generation engines, aero-engine applications in the context of advanced magnesium alloys and technology challenges in developing aero-engines.

Dr K Tamilamani, Director General (Aeronautics), DRDO insisted that efforts must be made to produce an indigenous engine as import dependence "costs the country heavily." Given the infrastructure already in place at HAL, he said that a concerted effort with proper regard to time lines was necessary. Mr S Subrahmanyan,

HAL Koraput is presently manufacturing the AL-31FP engine for the Su-30MKI

Managing Director HAL's MiG Complex outlined the growth and contribution of the Koraput Division. Since April 1964, the Koraput Division has manufactured and overhauled R-25, R-29B, RD-33 and AL-31FP engines to power the MiG-21, MiG-27, MiG-29 and Su-30MKI aircraft families respectively. Over course of the last 50 years, the Division has manufactured a total of 1,574 aero engines engines and overhauled 7,417.

HAL Koraput is presently augmenting its capacity for manufacture and overhaul of larger numbers of AL-31FP engines, and overhaul of RD-33MK engines. In addition, the Division is in the process of establishing manufacturing facilities for AL-55I engines for the HJT-36 Intermediate Jet Trainer (IJT) and the High Altitude Test Bed facility.

Indian-Chinese Border meeting

A meeting was held on New Year's Day 2015 between Indian Army and Chinese PLA personnel, the two delegations meeting on the Chinese side of the Line of Actual Control in the Chushul sector of Ladakh. This meeting suggested an improvement of relations between border forces along the LAC and included speeches which reflected "a mutual desire for maintaining and improving relations at the functional level on the border".

Brigadier JKS Virk and Colonel Fanjun during the meeting in eastern Ladakh

HONEYWELL

BRO under MoD

The Border Roads Organisation (BRO) will function under the Ministry of Defence from the next Financial Year. So far funded by BRO the Ministry of Road Transport and Highways, BRO undertakes tasks assigned by the Ministry of Defence but this dual control of BRO is "one of the principal reasons behind non-availability of funds and the organisation's lack of performance." BRO has failed to meet the deadlines in 73 strategic road projects on the India-China border, which were cleared by the Cabinet Committee on Security in June 2006. Also, as part of the re-structuring, around 6,000-7,000 km of nonsensitive roads in border areas will be handed over to the National Highways Authority of India.

India-Mongolia joint Army Exercise

The tenth India-Mongolia joint training exercise '*Nomadic Elephant*' commenced at Gwalior on 23 January 2015, with aim of the platoon-level exercise being "to acquaint both armies with each other's operating procedures in the backdrop of a counter-insurgency and counter-terrorist environment".

The Mongolian contingent was from the 84th Airborne Special Forces Battalion, which participated alongside an Indian infantry platoon over 15 days. The exercise involved special helicopter operations, water patrolling, handling and neutralisation of IEDs and conduct of cordon and search operations, "while serving in peacekeeping missions under a United Nations mandate".

India and Vietnam to strengthen military ties

India and Vietnam are seeking to further enhance bilateral military cooperation, holding a strategic defence dialogue in New Delhi on 16 January 2015. Deputy Defence Minister Senior Lt Gen Ngyyen Chi Vinh led the Vietnamese delegation, while the Indian side was headed by Defence Secretary RK Mathur. Lt Gen Vinh also called on National Security Advisor Ajit Doval and Army Chief General Dalbir Singh Suhag.

Su-30MK2 of the Vietnam People's Air Force

Although details of the meeting are not revealed, it is understood that critical issues relating to military matters in South and South-East Asia were discussed, along with proposals for defence exports to Vietnam and training of Vietnamese military personnel. Vietnam is reportedly to procure four patrol vessels under a line of credit extended by India, the ships intended to monitor Vietnamese territorial waters. India is already training Vietnam Navy personnel on Russian-origin *Kilo*-class submarines operated by both forces. Importantly, discussions have been held for the training of Vietnam Air Force personnel on the Sukhoi Su-30MK2, a variant of the MKI operated by the IAF.

First HAL-overhauled Su-30MKI

HAL delivered the first overhauled Su-30MKI (SB027) to the Indian Air Force at HAL Nasik on 9 January 2015. Defence Minister Manohar Parrikar handed over acceptance certificates of the overhauled aircraft as well as the 150th Su-30MKI (SB190), manufactured by HAL to Air Chief Marshal Raha. Speaking on the occasion, the Defence Minister lauded efforts made by HAL in absorbing technology and described the Nasik employees as "excellent and motivated," and urged them to keep up their work towards increasing production capacity. The CAS said that the Indian Air Force and HAL are "inter-dependent" and the IAF would continue to depend heavily on HAL heavily in the future.

File picture of IAF Sukhoi Su-30MKI (by Simon Watson)

Dr RK Tyagi, Chairman HAL stated that the company would "act as a single-window OEM for supporting the Su-30MKI fleet" and was confident that fleet serviceability could be improved. The Su-30 overhaul facility at HAL Nasik is the only one of its kind in the world, and Dr Tyagi feels it has "export relevance" since nearly 10 countries operate the Su-30.

MiG

CAS inaugurates new IAF Pilot Selection System

Air Chief Marshal Arup Raha inaugurated the new Computerised Pilot Selection System (CPSS) on 28 November 2014 at No. 2 Air Force Selection Board (AFSB), Mysore. The new CPSS replaces the earlier Pilot Aptitude Battery Test (PABT) that has been used for decades. The CPSS was conceived by the then-Scientific Advisor to PM, Dr APJ Abdul Kalam, with the means to adopt better tools for Pilot Aptitude Test in consonance with modern aircraft being acquired by the IAF. The project was also aimed at addressing the issue of the alarming rate of flying accidents in the IAF attributed to pilot error.

CPSS has been jointly developed by the Defence Institute of Psychological Research (DIPR) and the Air Defence Establishment (ADE). The new selection system places special emphasis on psychomotor skills and cognitive abilities of the candidates while screening them for selection into the flying branch of the IAF. The computerised pilot selection system ensures objectivity in results and uniformity in the degree of difficulty faced by the candidates.

CAS visits Indonesia

Air Chief Marshal Arup Raha visited Indonesia 23-26 November on an invitation from Air Chief Marshal Ida Bagus Putu Dunia, Chief of Staff Indonesian Air Force, the first visit by an Indian CAS to Indonesia in over a decade. This follows the summit meeting between Indonesian President Joko Widodo and Prime Minister Narendra Modi at the East Asia Summit in Nay Pyi Taw, Myanmar, during which enhancement of defence cooperation was one of the key points of discussion.

Air Chief Marshal Arup Raha with the Base Commander at Yogyakarta and pilots of the Indonesian Air Force 'Jupiter Aerobatics team'.

The Indonesian Air Force has expressed interest to increase scope of cooperation with the IAF through greater interaction in the future. General (retd) Ryamizard Ryacudu, Indonesian Minister of Defence was "appreciative" of ongoing initiatives in the field of "defence cooperation" and underlined the immense potential for further engagement between the two Armed Forces.

Air Chief Marshal Raha also visited Indonesian aircraft manufacturer PT Dirgantara at Bandung and saw production and maintenance facilities, complimenting PTDI for their efforts on indigenisation. During his visit to the Indonesian Air Force Academy at Yogyakarta, the IAF CAS addressed cadets at the interacted with the *Jupiter Aerobatics Team* which fly the Korean KT-1 basic trainer. (*The Indian Air Force had trained large numbers of Indonesian cadets in the 1950s at various facilities in India : Ed*).

127th NDA Course Passing Out Parade

General Dalbir Singh, Chief of Army Staff, reviewed the passing out parade of the 127th National Defence Academy Course at Khadakwasla on 29 November 2014. 355 cadets graduated from the Academy, and included ten cadets from Tajikistan and five from Afganistan. In his address, the COAS congratulated the future leaders of armed forces and their parents on the occasion and explained the relevance of 'thinking soldiers' in the present day scenario, yet reiterated that the fundamentals of drill and inculcation of discipline can never be undermined.

A flypast by Mi-17V5 helicopters followed by three Super Dimona aircraft, each in 'vic' formation, and a grand finale by three Su-30MKIs climaxed the event.

Record citations for the Sikh Regiment

The Sikh Regiment set a record on Army Day 2015 (15 January), with six of its units being awarded Chief of Army Staff Citations and Army Commander's Appreciations, the highest number of such awards given to any regiment in a single year. The honours are granted in recognition of outstanding achievements in the face of enemy action, in aid to civil authorities and in sustained exceptional performance over the course of a calendar year. The units awarded are: 6 Rashtriya Rifles (Sikh) for outstanding achievement in counter-terrorism/counter-insurgency operations, 4 Sikh, 10 Sikh, 14 Sikh, 157 Infantry Battalion (Territorial Army, Sikh) and the Sikh Regimental Centre.

In mid-2014, the number of battalions of the Sikh Regiment was increased by one more (the 23rd) at which time Colonel of the Regiment Lt Gen GS Shergill commemorated the event at the Regimental Centre at Ramgarh, with a special '*Sainik Sammelan*'.

The Sikh Regiment contingent on parade in Delhi during Army Day 2015 (photo: Angad Singh)

INS *Arihant* SSBN commences sea trials

In a major step toward validation of such advanced defence technologies, the Indian-built nuclear-powered ballistic missile submarine INS *Arihant* completed its harbour trials and set out for sea trials from Visakhapatnam harbour on 15 December 2014 (*see article in this Issue)*.

Built under the classified Advanced Technology Vessel (ATV) project monitored directly by the Prime Minister's Office, the 6,000 tonne nuclear-powered submarine emerged from the breakwaters of the Visakhapatnam harbour, monitored by a low flying helicopter and sailed into the Bay of Bengal as part of its sea trials, traveling north along the coast before heading out into open waters.

Cochin Shipyard launches 13th FPV

On 17 January 2015 Cochin Shipyard (CSL) launched the 13th Fast Patrol Vessel (FPV) of a series of twenty being built for the Indian Coast Guard. The vessel, formerly known by its yard number BY-513, was named ICGS *Anmol* and launched at a ceremony at CSL. CSL has so far delivered 10 FPVs and the eleventh is getting ready for sea trials. The tenth vessel, ICGS *Amogh*, was handed over to the Indian Coast Guard on 9 January 2015. The same yard is constructing the Indigenous Aircraft Carrier (INS *Vikrant*), for the Indian Navy.

ICGS *Sankalp* on extended overseas deployment

The Goa Shipyard built-Indian Coast Guard Ship *Sankalp,* an advanced Offshore Patrol Vessel (OPV) undertook an overseas deployment of 32 days in November-December 2014, the vessel sailing to Singapore, Australia and Indonesia as part of international cooperation through exchange of information and bilateral exercises. This deployment was the first ever Australian port call from an Indian Coast Guard vessel, the five-day visit being "to strengthen the expanding maritime cooperation between the two nations". The visit highlighted a common interest in combating maritime threats in the region, search and rescue, marine pollution control, curbing of transnational crime and illegal fishing.

Atlas Elektronik to deliver six ACTAS towed sonars for Indian Navy

Atlas Elektronik and the Indian MoD have signed a contract for delivery of six active towed array sonar systems (ACTAS) for the Indian Navy, the contract value being some EUR 40 million with delivery of the first system is planned for 2016.

ACTAS operates in the low-frequency range and permits observation of the sea space at ranges in excess of 60 kilometres, depending on the sound propagation conditions of the water. The performance of ACTAS delivers to warships an exceptional operational range advantage over the radars and weapons systems employed by submarines. ACTAS can also locate and track surface vessels, which permits reconnaissance of both submarines and ships in the same sonar search area.

Vistara begins scheduled services

The Tata-Singapore Airlines joint venture carrier Vistara, launched scheduled services on 9 January with its first flight (UK 890) from Delhi to Mumbai. Vistara is the third full-service carrier in the country, after Air India and Jet Airways. The launch of this new airline also marks re-entry of the Tata Group in the airline business after six decades. The group also holds a 30 per cent stake in the domestic arm of the Malaysian budget airline AirAsia India.

Vistara had applied to the Directorate General of Civil Aviation (DGCA) for the flying permit in April 2014 but was granted this in late 2014. Vistara, which uses two leased A320s presently, will operate these configured with 148 seats: 16 in business class, 36 in premium economy and 96 in economy. According to a plan submitted by the airline to the DGCA, Vistara intends to operate a total of 87 flights from its Delhi base to Goa, Mumbai, Bengaluru, Ahmedabad, Hyderabad, Chandigarh, Srinagar, Jammu and Patna by the end of its first year of operations.

VT-TTB seen at Mumbai's new Terminal 2 after operating flight UK 890 from Delhi (photo: Vishal Jolapara)

Air India registers profit

Declining fuel prices and a 13.5 per cent increase in passenger revenue (net revenue increase of 6.5 per cent) saw Air India register a modest profit of Rs 14.6 crore in December 2014. This marks the first profitable month for Air India in the past calendar year. By comparison, Air India had posted a loss of Rs 168 crore in December 2013.

(photo: Angad Singh)

VIP-configured Superjet 100 in India

On 12 December 2014, during an Indo-Russian Summit aimed at "strengthening bilateral relations between the two countries", the Sukhoi Superjet 100 aircraft in VIP configuration was presented by Russian Deputy Minister of Industry and Trade, Yury Slyusar and the President of United Aircraft Corporation (UAC), Mikhail Pogosyan at New Delhi International Airport. "Sukhoi Civil Aircraft Company have been evaluating the Indian market for the Sukhoi Superjet 100 aircraft and assess the requirement as 50 aircraft until 2030", according to them.

Two days prior to the presentation, members of the Russian delegation headed by the Minister of Industry and Trade of the Russian Federation Denis Manturov flew to Delhi aboard the same aircraft for participation in the Summit. The aircraft operated non-stop from Moscow to New Delhi, covering a distance of 4,738 km in 6 hours and 5 minutes, making this the longest passenger flight operated by a production Sukhoi Superjet 100 aircraft.

The Sukhoi Superjet 100 at India Aviation Show, Begumpet (Hyderabad) in 2012 (photo : Angad Singh)

SpiceJet's revival plan

The Government of India has approved the low cost carrier SpiceJet's "reconstruction and revival" plan. This was submitted to the Civil Aviation Ministry by new investors including the airline's co-founder Ajay Singh, and the ministry has referred to his

plan to infuse Rs 1,500 crore by end March 2015 along with new owners to stock market regulator Securities and Exchange Board of India (Sebi). The airline's new owners, taking over from Kalanithi Maran, will hold about 59% stake in the company.

However, while SpiceJet's current fleet consists of 19 Boeing 737s along with 15 Bombardier Q400s, some lessors are reportedly terminating the lease agreements currently with SpiceJet. Meanwhile, SpiceJet COO Sanjiv Kapoor has stated in a tweet : "... company is changing hands and being recapitalised, this will take care of legacy issues. We are working on it 24x7." The company has restarted scheduled services and has registered a 6.6% rise in traffic.

Maiden flight of the 'Panchi'

Panchi, a wheeled variant of DRDO's Nishant UAV, which is designed for takeoff / landing from small airstrips instead of a dedicated launcher, made its maiden flight on 24 December 2014. Lasting about 20 minutes, the first flight was preceded by a series of high-speed taxi trials. The Panchi UAV retains surveillance capabilities of the Nishant, but will have longer endurance, as it does not have to carry the air bags and parachute recovery system required by the Nishant.

Dr K Tamilmani, DS and DG Aeronautical Systems said that "aggressive efforts" by the ADE team over the past 8 months had led to the successful flight. The Indian Army has already inducted the Nishant as a multi-mission UAV with day/night all-weather operational capability, designed for battlefield surveillance and reconnaissance, target tracking and localisation, and artillery fire correction. The UAV has a jam resistant command link and digital down link for transmission of imagery. It also incorporates autonomous flight capabilities.

Canisterised Agni 5 ICBM test fired

India's Agni 5 Inter Continental Ballistic Missile (ICBM) was successfully test fired from a canister on 31 January 2015 at 0809 hrs, the missile after launch following its predetermined path during which the second, all composite light-weight motor, followed by the third, innovatively designed conical all-composite rocket motor propelled the missile into space taking it to a height of more than 600 km. The missile, after reaching its peak trajectory, turned earthward to continue its descent towards the intended target with speed now increasing owing to the earth's gravitational pull, its path precisely directed by the advanced on-board computer and inertial navigation system. Agni 5 impacted on target as determined by the modern micro inertial navigation system (MINS), fully digital control system and advanced compact avionics, tracked and witnessed by ships located in midrange and the target point.

Agni 5 lifts off on launch

This was Dr Avinash Chander, outgoing SA to RM, Secretary DDR&D and DG DRDO's last day in office, who said that "this was a copy book launch" with the entire command network operating in loop. He was obviously jubilant when he stated "this is a momentous occasion. It is India's first ever ICBM launch from a canister and is a giant leap in country's deterrence capability".


Avinash Chander's last hurrah !

The earlier two flights of Agni 5, also fully successful, were in open configuration and had already proved the missile. This launch from a canister integrated with a mobile sophisticated launcher, was in its deliverable configuration which enables launch of the missile with very short preparation time and also has advantages of higher reliability, longer shelf life, less maintenance and enhanced mobility.

1000 kg guided glide bomb

A 1000 kg glide bomb designed and developed by the DRDO was successfully tested on 19 December 2014 in the Bay of Bengal off the coast of Odisha. The bomb which was dropped by an IAF aircraft and guided by the on board navigation system, glided for nearly 100 km before hitting its target, with flight of the glide bomb monitored by radars and electro-optic systems stationed at the Integrated Test Range (ITR). The complete avionics package and navigation system has been designed and developed by Research Centre Imarat (RCI).

CIINCA strategy to accelerate 'Make in India' drive

With increasing focus on achieving self-reliance in defence, Confederation of India Industry's National Committee on Aerospace (CIINCA), under the Chairmanship of Dr RK Tyagi, Chairman HAL, deliberated on various strategies for the aerospace sector in its second meeting on 18 December 2014.

Key issues discussed during this maiden meeting were strategies on import substitution, proposals on taxation, collaboration with foreign OEMs, developing supply chain, promoting Indian Tier-1, Tier-2 companies and SMEs through structured programmes were discussed further by the leaders from national and international companies including Saab India, Safran India, Mahindra Aerospace, Raytheon, Maini Aerospace, Rolls-Royce India and others.

Indra to modernise air control centre in Delhi

The Airports Authority of India (AAI) has contracted Indra Sistemas to modernise Delhi's air control centre, one of the most important in the country, which manages one of the busiest air traffic areas in India including at New Delhi international airport. The firm will now provide 140 controller positions and an advanced automated air traffic management system for Delhi's approach and route centre, which will enable operators to have an integrated view of all aircraft movements in the airspace under their responsibility. It will also detect potential route conflicts and calculate possible alternatives. Additionally, it will expedite coordination with other control centres and facilitate communication with pilots. Indra also recently completed and handed over the Calcutta control centre to AAI and this centre is already using the company's technology to manage traffic in the region.

BHEL, MIDHANI and HSL co-operate on P-75(I) project

Three state-run companies—Bharat Heavy Electricals Ltd, Mishra Dhatu Nigam Ltd and Hindustan Shipyard Ltd—have formed a consortium for indigenous submarine production. The consortium will jointly stake claim with the Ministry of Defence for being considered as a prospective bidder for the proposed P-75 (I) project of the Indian Navy for building six submarines at an Indian shipyard. A memorandum of understanding was signed by the three firms on 26 December 2014.

The Indian government has decided to build six submarines domestically at a cost of about Rs 50,000 crore. BHEL has five decades of experience in design, development and manufacture of a variety of equipment for crucial infrastructure sectors, while HSL is engaged in shipbuilding, repairs and submarine retrofitting. MIDHANI is a defence PSU engaged in development and manufacture of alloys and special-purpose steel for applications in defence, aerospace and atomic energy.

Tata-Lockheed Martin Aerostructures facility

A team of senior Lockheed Martin executives led by Patrick Dewar, Executive Vice President, Lockheed Martin International, visited the Tata-Lockheed Martin Aerostructures Limited (TLMAL) facility in Hyderabad on 21 January to inspect C-130J components manufactured there as well as to tour the TLMAL site.

Patrick Dewar (4th from left) with Tata and Lockheed Martin executives at the TLMAL facility in Hyderabad

Set up in 2012, TLMAL manufactures airframe components for the global supply chain of the C-130J Super Hercules, and won an award for 'best joint venture' at the 2013 *Aerospace & Defence Awards*. Tata Advanced Systems holds a 74% stake in the joint venture, with Lockheed Martin holding the remaining 26%.

Dewar praised the partnership, saying that the success of the JV had "strengthened" Lockheed's relationship with Indian military customers and "reinforced the company's commitment to and partnership with Indian industry". Lockheed Martin has already supplied six C-130J Super Hercules aircraft to the Indian Air Force, and has signed a follow-on agreement for six more, to be based at Panagarh in West Bengal.

Agni 4 successfully tested

The 4000 km-range ballistic missile Agni 4 was successfully launched from Wheeler Island off the Odisha coast on 2 December 2014. Long-range radars and Electro-Optical Tracking

Systems (EOTS) located along the coast tracked and monitored all missile parameters throughout the flight, which was the fourth successful launch in a sequence.

The launch operations were carried out by the Strategic Forces Command (SFC) and witnessed by senior DRDO officials. Agni 4 is equipped with contemporary avionics, including a 5th generation onboard computer, distributed architecture, a highly accurate Ring Laser Gyro (RLG) based Inertial Navigation System (INS) supported by redundant, highly reliable Micro Navigation System (MINGS), ensuring a low CEP (Circular Error Probability). The missile's heat shield is capable of withstanding temperatures over 4000°C during re-entry, and ensures that avionics function normally, with internal temperature remaining under 50°C.

GSAT-16 successfully launched

After two launch deferments owing to bad weather, India's latest communication satellite, GSAT-16, was placed into orbit by an Ariane 5 rocket on 7 December 2014 from the Kourou spaceport in French Guiana. The European launcher carried GSAT-16 into Geosynchronous Transfer Orbit (GTO). The Indian satellite's co-passenger DIRECTV-14, built by Space Systems/Loral LLC, for TV operator DIRECTV to provide direct-to-home television broadcasts across the USA, was also launched, marking the 63rd successful mission in a row for the Ariane 5 rocket.

With a lift-off mass of 3,181 kg, GSAT-16 carries a total of 48 communication transponders, the largest by a communication satellite developed by the ISRO so far. Soon after the launch, ISRO's master control facility at Hassan in Karnataka took over command and control of the satellite, reporting that it was "in good health."

ISRO tests GSLV Mk.III and crew module

On 18 December 2014, ISRO successfully tested atmospheric re-entry of an unmanned crew module launched by a GSLV Mk.III rocket from the Satish Dhawan Space Centre in Sriharikota. Exactly 5.4 minutes after lift-off at 9.30 am from the Second Launch Pad at the Space Centre, the module separated from the rocket at an altitude of 126 km and re-entered Earth's atmosphere, descending in ballistic mode to splash down into the Bay of Bengal, some 180 km from Pygmalion Point, southernmost tip of the Andaman and Nicobar Islands.

The LVM3-X flight with active S200 and L110 propulsion stages and a passive C25 stage with dummy engine, carried only CARE (Crew Module Atmospheric Re-entry Experiment) as its payload. Weighing over three tonnes, the 2.7-metre tall crew module with a diameter of 3.1 metres, which features aluminium alloy internal structure with composite panels and ablative thermal protection systems, was made to safely drop down into the sea by specially made parachutes from Agra-based DRDO lab Aerial Delivery Research and Development Establishment. The mission is a step toward eventual manned spaceflight from India.

ISRO and HAL partner on cryogenic rocket engine

Then ISRO Chairman Dr K Radhakrishnan laid foundation stone for the Integrated Cryogenic Engine Manufacturing (ICEM) facility at HAL Bangalore on 1 December 2014. The facility is being set up over a built-up area of 5,560 sq m opposite HAL's Aerospace Division and will be manned by HAL personnel. ISRO will fund the facility to the tune of Rs 139 crore. HAL has partnered and supported ISRO throughout its journey by providing hardware for satellites, SLV, ASLV, PSLV, GSLV Mk.II and GSLV Mk.III (LVM3).

Speaking on the occasion, Dr Radhakrishnan, hailed HAL's contribution to ISRO. "We remember HAL every time we succeed in our missions, the Mars Orbiter Mission being the latest. We have been partners in progress and will continue to be so in future too," he said. The major facilities planned at this upcoming ICEM unit include the rotary vacuum brazing facility, machineries for sheet metal forming, CNC machines (primarily 5-axis) for complex

Dr K Radhakrishnan, Chairman, ISRO releasing blueprint of the Integrated Cryogenic Engine Manufacturing (ICEM) project in Bangalore, seen with (then) HAL Chairman Dr RK Tyagi (right)

geometry machining, tungsten inert gas/metal inert gas welding and heat treatment facilities for special materials and testing facilities. The new facility is expected to have a turnover of some Rs 9 crore per year.

Yves Guillaume receives top French award

The French Ambassador to India, HE François Richier, conferred the insignia of *Knight of the Legion of Honour* on Yves Guillaume, President India, Airbus Group at a ceremony held in New Delhi on 30 November 2014. France's highest civilian honour for Yves Guillaume came in recognition of his "exemplary personal commitment to the growth and promotion of the French aerospace industry." The decoration was announced by the Ministry of External Affairs, Government of France, on occasion of the French National Day on 14 July 2014.

Yves Guillaume is based in New Delhi and has been President India, Airbus Group since June 2006. Under his leadership, Group turnover in India has risen and local industrial footprint has expanded, with Indian companies, both public and private, now firmly embedded in the Group's value chain.

APPOINTMENTS

Air Marshal Sukhchain Singh takes over as AOM

Air Marshal Sukhchain Singh VSM assumed the responsibilities of Air Officer–in-Charge Maintenance at Air HQ, New Delhi on 1 December 2014. The Air Marshal was commissioned in the Electronics stream of the Aeronautical Engineering branch in IAF on 2 July 1979, is a graduate in Electronics and Communication from REC Kurukshetra (now NIT) and a postgraduate in Integrated Electronics from IIT Delhi. He is also an alumnus of the prestigious Defence Services Staff College, Wellington, was awarded the Vishisht Seva Medal in January 1999 for distinguished service, and has rich experience in the field of maintenance management of aircraft, radars and guided weapons.

Prior to assuming the present assignment, the Air Marshal Sukhchain Singh has held various important staff and field appointments, notably as Senior Maintenance Staff Officer at Maintenance Command, Assistant Chief of Air Staff (Engineering B) at Air HQ, Senior Maintenance Staff Officer at South Western Air Command, Chief Engineering Officer of an Air Base and Chief Research & Projects Officer at the Aircraft Systems Testing Establishment (ASTE), Bangalore.

Lt Gen Pranab Kumar Bharali appointed DG Army Aviation Corps

Lt Gen Pranab Kumar Bharali has been appointed as Director General of the Army Aviation Corps. He had graduated from the National Defence Academy, Khadakvasla and was commissioned as an officer in the Army in June 1977.

Having been trained as a helicopter pilot he served as a flying instructor and commanded a helicopter unit.

He has held the post of the General Staff Officer (Operations) at the Counter Insurgency Force Headquarters was Colonel Administration of a Division, Brigadier Aviation of the Command Headquarter in Jammu & Kashmir before assuming the post of Additional Director General, Army Aviation Corps at New Delhi.

Air Marshal SB Deo is AOC-in-C EAC

Air Marshal SB Deo became AOC-in-C Eastern Air Command on 1 January 2015, taking over from Air Marshal RK Jolly who retired from service on 31 December 2014. A Fighter Combat Leader and a Qualified Flying Instructor, Air Marshal Deo has held various staff and field appointments during a career spanning over 35 years. Prior to taking over as AOC-in-C, he was Director General (Air Operations) at Air HQ.

Sukaran Singh appointed MD & CEO of Tata Advanced Systems

Sukaran Singh has been appointed Managing Director and Chief Executive Officer of Tata Advanced Systems Limited (TASL), Tata Sons' subsidiary for its aerospace and defence business. He had joined the Tata Group in 2003 and is a Director at TASL.

The Tata Group has identified aerospace and defence as a focus area, and TASL provides integrated solutions for aerospace, defence and homeland security. The firm has grown to become a significant player in the global aerospace market, partnering with global OEMs such as Sikorsky, Lockheed Martin and Pilatus on various programmes. In addition, TASL is engaged in development and assembly projects for missiles, radars and other high technology products for Indian customers.

Air Marshal Jagjeet Singh is AOC-in-C Maintenance Command

Air Marshal Jagjeet Singh VSM has taken over as Air Officer Commanding-in-Chief at Headquarters Maintenance Command, Nagpur on 1 December 2014.

After completing his Bachelor of Engineering Degree in Electrical Engineering from Patiala in 1976, he joined the Indian Air Force in 1977 and was commissioned in the Aeronautical Engineering Branch. He is also a postgraduate in Electrical Engineering from Punjab University, Chandigarh and is a Post Graduate Diploma holder in Management from IGNOU. He has also completed the Technical Staff Course at IAT, Pune.

Air Marshal Jagjeet Singh has considerable experience in maintenance management of aircraft and systems and has held various field and staff appointments. He has commanded a Technical Type Training School for fighter aircraft and a Base Repair Depot. He has also held the appointments of Chief Engineering Officer at Air Force Academy, Command Engineering Officer at HQ SWAC and Senior Maintenance Staff Officer at HQ Central Air Command. The Air Officer was holding the appointment of Air Officer-in-Charge Maintenance at Air HQ before assuming his present post.

New Director General Coast Guard

Vice Admiral HCS Bisht AVSM took over as the 21st Director General Indian Coast Guard on 38th Raising day of the Service on 1 February 2015, succeeding Vice Admiral Anurag Thapliyal. Vice Admiral Bisht was commissioned in the Executive Branch of the Indian Navy on 1 July 1979 is a Gunnery Specialist, and is a graduate of the 1992 batch of the Royal Naval Staff College, Greenwich (UK).

The Admiral has held a number of important afloat, training and staff appointments which includes commissioning Commanding Officer of the Missile Corvette INS Kora, Commanding Officer of the Stealth Frigate, INS Tabar and DA at the High Commission of India, Singapore. His flag appointments include Assistant Controller of Carrier Projects, Chief of Staff Southern Naval Command, Flag Officer Sea Training at Kochi, Flag Officer Commanding Eastern Fleet at Visakhapatnam, Asst Chief of Personnel (HRD) and Controller Personnel Services (CPS) at IHQ, MoD(N).

T. Suvarna Raju takes over as Chairman HAL

Mr T Suvarna Raju, who has been Director Design & Development HAL, has been entrusted with additional charge as Chairman of HAL, taking over on 31 January 2015. He had joined HAL on 26 June, 1980 as Management Trainee and over the past 35 years has held several critical positions. Under his leadership he led HAL teams on various research and development programmes which included the Tejas LCA, LUH, LCH, IJT, HTT-40, Jaguar DARIN-III, Mirage Upgrade and others. He implemented the concurrent engineering to facilitate the development and production of new aircraft types as also developed the concept of performance based logistics for military aircraft.

Mr Raju was responsible for establishing the production line for Hawk Mk 132 advanced jet trainers and their deliveries on schedule. He managed the Mirage 2000 aircraft maintenance project without any cost over-run, having earlier been involved with HAL Bangalore Complex in production of the Jaguar strike fighter and establishment of overhaul facilities.

Mr. Raju has been member of various High Level Teams formed by Ministry of Defence (MoD) for assessing the techno-economic viability of new acquisitions. Mr Raju led drafting of HAL's first R & D policy, the organization having applied for an unprecedented 1000 patents in last two years. He also conceptualised, prepared and implemented a number of automation and real-time systems.

Air Marshal S Neelakantan takes over as AOP

Air Marshal S Neelakantan YSM VM, took over as Air Officer-in-Charge Personnel (AOP) at Air Headquarters on 2 February 2015. He was commissioned as a fighter pilot in the Indian Air Force in December 1977 and is an alumnus of the National Defence Academy, Defence Services Staff College, Wellington, and TACDE.

As a qualified flying instructor, he has over 3100 flying hours on various aircraft types, has commanded a frontline fighter squadron and two air bases. He led the Indian Air Force contingent in the Congo as part of the UN peacekeeping mission in 2006-07 and has also held various staff and instructional appointments. He was Director General of Inspection and Safety before taking over as AOP.

Air Marshal Jasjit Singh Kler is DG (Inspection & Safety) IAF

Air Marshal Jasjit Singh Kler VM has assumed appointment of Director General (Inspection & Safety) on 2 February 2015.

The Air Marshal is a Qualified Flying Instructor, has flown close to 8000 hrs on various helicopters, flying mostly in the Siachen Glacier and the Eastern Sector, having operated most types of helicopters in the IAF's inventory.

Air Marshal JS Kler has held various command and staff appointments which include SAASO of Maintenance Command, was Deputy Commandant of the Air Force Academy, AOC of Air Force Station New Delhi, Station Commander AFS Jammu and Salua and as also CO of a Mi-17 Helicopter Unit. He also was posted to Namibia to raise and train that country's helicopter element. Prior to his present appointment, he was IG (Air), BSF Air Wing, MHA.

Dassault

New DG for DGCA

The government has appointed Mrs M Sathiyavathy as director general of civil aviation (DGCA), taking over from Prabhat Kumar. She was previously additional secretary and financial adviser to the Ministry of Civil Aviation, and had also served as Chief Secretary in the Puducherry government.

The DGCA is working to restore India's aviation safety ranking, which was downgraded in 2014 by the US Federal Aviation Administration (FAA) owing to poor regulatory oversight. DGCA, as the aviation regulator, registers civilian aircraft, formulates standards of airworthiness for aircraft, licenses pilots, air traffic controllers and engineers and grants air operating permits to Indian airlines. A third FAA audit of the DGCA ended in December 2013, and reportedly found the Indian regulator in "much better shape than before", with DGCA officials expecting that India's safety ranking would be restored by March 2015.

Air Marshal Anil Khosla is DG Air Operations

Air Marshal Anil Khosla took over as Director General Air Operations at Air Headquarters on 12 January. commissioned in the fighter stream in December 1979, he has over 4000 hours of flying experience, has vast instructional experience and has been Directing Staff at the Tactics and Combat Development Establishment (TACDE) and Flying Instructor School (FIS). He has commanded No.6 Squadron (Jaguar maritime strike) and two frontline bases of the IAF at Jaisalmer and Ambala, and has held various staff appointments at Air HQ including: Principal Director at Directorate of Information and Electronic Warfare, Director in Personnel Branch and Joint Director at Directorate of Concept Studies. In the rank of Air Vice Marshal, he has held the appointment of Air Officer Commanding HQ Maritime Air Operations and Air Officer Commanding J&K Area. His last appointment was as Senior Air Staff Officer, Central Air Command.

Deepak Parekh appointed Chairman, BAE Systems India

BAE Systems has appointed Deepak Parekh, Chairman of HDFC Ltd, as non-executive Director and Chairman of its Indian subsidiary, BAE Systems India (Services) Private Limited, with effect from 1 January 2015.

Deepak Parekh's association with BAE Systems began in 2010 when he was member of the company's Independent Advisory Board for India, and in his new role as Chairman, he will provide leadership to BAE Systems India and "help the firm realise its aspiration to develop capabilities and infrastructure in the country in support of Prime Minister Modi's 'Make In India' initiative".

Corrigendum

Thales appoints Antoine Caput Vice President & Country Director for India

Antoine Caput is Thales' new Vice President and Country Director for India, based in New Delhi, taking charge on 1 November 2014. An accomplished professional with extensive experience in the ground transportation sector, Antoine is responsible for all Thales operations in India. He was, until recently, in charge of Thales's road tolling and traffic control business. Before joining Thales in 2000, Antoine spent 10 years at Alcatel CGA, where he was in charge of export sales for East Asia. At Thales, Antoine has held various senior positions in contract management and later in purchasing. From 2005 to 2007, he managed Thales's joint venture with Panda Electronics in Nanjing, China. He is a graduate of the Institut Supérieur de Gestion de Paris.

(an incorrect photograph of Antoine Caput was mistakenly published in Vayu VI/2014)

LCA Navy maiden flight from SBTF ski-jump

Around noon on 20 December 2014, as holidaymakers soaked up the sun and surf at Bogmalo beach near Goa's Dabolim airport, the LCA (Navy) prototype KHN-T-3001 (NP-1) successfully launched off the ski-jump at the Shore Based Test Facility (SBTF) at INS *Hansa*. This naval variant of the Tejas LCA that was recently accepted by the Indian Air Force (*see article in this issue*) has already made a number of flights but these were conventional from runways in Bangalore. December 2014 marked first time that the N-LCA was launched from the ski-ramp of the SBTF, which replicates the deck layout of the aircraft carrier INS *Vikramaditya* as well as the new INS *Vikrant* (IAC-1), which is under construction at Cochin Shipyard Limited.

Piloted by Commodore Jaideep Maolankar, Chief Test Pilot of the National Flight Test Centre (NFTC), the aircraft reportedly had "a perfect flight" performing "better than predicted". This first launch was orchestrated by the Test Director, Cdr JD Raturi and Safety Pilot Capt Shivnath Dahiya, supported by Gp Capt Anoop Kabadwal, Gp Capt RR Tyagi and Lt Cdr Vivek Pandey.

Dr Avinash Chander, then SA to RM, Secretary DDR&D and DG DRDO, congratulated the LCA Navy programme team saying, "With today's copybook flight of LCA-Navy from the land based ski-jump facility we will soon see our own indigenous combat aircraft flying from the decks of our aircraft carriers." Dr K Tamilmani, DS & DG Aeronautics, was similarly effusive, telling the team that their difficult task had been "executed beautifully."

Although the N-LCA has flown numerous times in the past, having made its maiden flight from shore on 27 April 2012, the ski-jump launch is a major milestone for the LCA Navy programme, marking culmination of several years of design, flight test, simulation and management efforts with significant contributions from a number of Indian defence research and development agencies. The programme has been constantly supported by certification agency CEMILAC and quality assurance agency CRI (LCA). Led by Programme Director ADA PS Subramanyam, the design teams ensured that all systems meet the stringent requirements of carrier operations. Cmde CD Balaji (Retd), Chief Designer and Project Director LCA (Navy), has been at the helm of the programme since conception, providing much-needed continuity to the development effort, while the flight control law team, led by Dr Amitabh Saraf, was responsible for ensuring that the fly-by-wire system worked flawlessly during the ski-jump take off.

Appearing at first glance to be broadly similar in layout and propulsion to its land-based IAF counterpart, the LCA (Navy) in fact incorporates significant changes. Most importantly, it features movable leading edge sections near the wing root, called leading edge vortex controllers (LEVCONs) which are essential in maintaining airflow over the wing across the flight envelope required by shipboard operations. The N-LCA also features modified landing gear, stronger and differently configured to better cope with the rigours of ski-jump launches and arrested landings. It has a special flight control law

mode that allows for near hands-free take off, reducing pilot workload in this critical phase of flight. All these changes result in an aircraft that can take off in 200 metres (as opposed to the 1000 metres or more required by land-based aircraft). In addition, the forward fuselage is reshaped to provide a better view to the pilot during take off and landing.

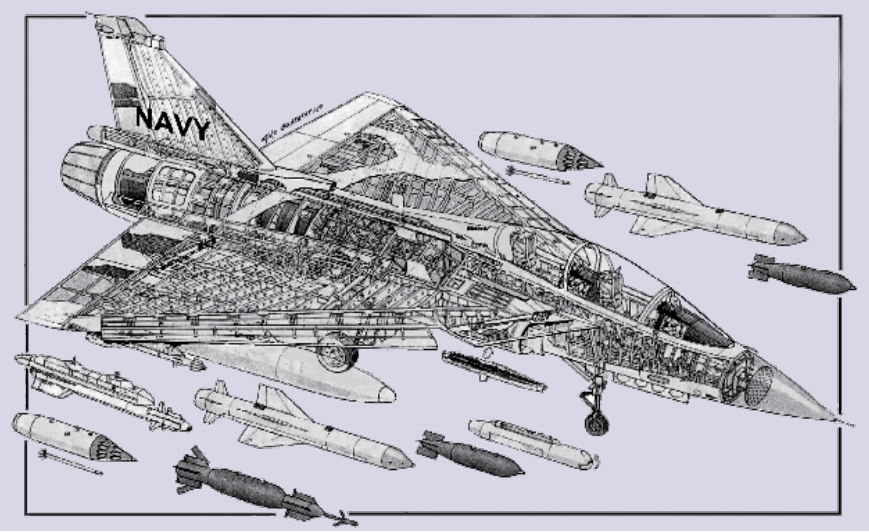
SBTF test campaign

According to Dr K Tamilmani, the first phase of SBTF tests with NP-1 included five additional launches to gather a large data set for further analysis and possible refinement. All these launches were conducted with the aircraft in a 'clean' configuration (no stores). Based on the results from the first set of tests, a second phase of testing is planned and will likely be conducted in March 2015, and may also include launch tests with stores (weapons and tanks) in place.

While the initial testing phases involve only ski-jump take offs, Dr Tamilmani indicated that arrested landing trials for the N-LCA will be conducted toward the end of 2015. He also said that the second N-LCA prototype (NP-2) is due to make its first flight from Bengaluru soon, and will join the test campaign shortly thereafter.

Indian Navy plans

Rear Admiral Davinder M Sudan, ACNS (Air) called the successful launch "a historic event" and noted that the Navy has "a great deal of faith" in this indigenous development programme. Although the Navy has not yet officially named the aircraft (it is not likely to enter Indian Navy service with the same 'Tejas' moniker as its land-based equivalent), it is clear that the maritime service has elaborate plans for indigenous naval aviation programmes.



Cutaway drawing of the LCA Navy (as visualised by Motocar)

The Navy presently has 8 N-LCAs on order, these being 'navalised' versions of the Tejas Mk.I, with the same GE F404 engine. However, the well-documented weight and power issues faced by the Tejas Mk.I will only be exacerbated in the challenging environment of carrier operations, and the Navy is clear that their definitive indigenous fighter is to have an expanded performance envelope, longer endurance and higher payload compared to the current N-LCA standard.

The solution to these limitations is more power – to be provided by the already contracted-for GE F414 engine – and weight reduction of the aircraft structure. The LCA in both land-based and naval versions is well above target weight limits set by the respective Services, but an increase in wet thrust from the current GE F404's sub-90 kN to the F414's 98 kN would likely yield sufficient levels of performance. A simultaneous reduction in operating empty weight would only add to the performance provided by a new engine. However, this must be expedited, as it is understood that work on an N-LCA Mk.2 has yet to begin !

Angad Singh

ISRO's PSLV C25 carrying the Mars Orbiter Mission (MOM, also known as Mangalyaan) seen at launch from the SatishDhawan Space Centre, Sriharikota

Prospects for Indian space technology

India's space programme has made great strides since its modest beginnings in the 1960s. In the initial years, it focused on design and building of simple satellites and in later years, gained expertise in designing and building very complex ones. Indian Space Research Organisation (ISRO) then moved to reduce its dependence upon foreign space launch facilities through initiation of the indigenous launch vehicle programme. Starting with the Satellite Launch Vehicle-3 (SLV3) which could take a mere 40 to 50 kg to low earth orbit (LEO), it has incrementally progressed to the ability to launch heavier satellites on its augmented SLV (ASLV), Polar SLV (PSLV), and Geosynchronous SLV (GSLV) launchers; the latest variant of the GSLV, the GSLV Mk-III, can take up to 5 tons to geosynchronous orbit (GEO). ISRO is reportedly now moving to develop capabilities to reduce the cost of launching payloads to space through development of newer launch technologies.

Media has reported that ISRO plans to test fly its Reusable Launch Vehicle (RLV) in March 2015.It is also reported by the same newspapers that India plans to launch the next two satellites for the Indian Regional Navigation Satellite System (IRRRNSS) this year.All services that require accurate navigation signals in the civil as well as military domains in India currently use the American satellite navigation based Global Positioning System (GPS) or the equivalent Russian Global Navigation Satellite System (GLONASS). Being foreign systems, GPS and GLONASS are subject to the larger interests of the technology owners involved. Such ISRO plans made public bode well for India's space technology sector.

Like in so many other high technology fields, today's rocket science found its first expression through the efforts of German scientists during the mid-twentieth century. These initial efforts were aimed at the use of rocketry in war, but none the less, led to the development and maturing of the basic building blocks upon which most of today's rocket technology is based. After the end of World War I both the erstwhile Soviet Union and USA utilised captured scientific knowledge from defeated Germany to advance their rocket programmes. These efforts led to the Soviet Union, followed by USA, becoming the first nations to achieve space access. Proliferation of rocket technology led to European countries achieving similar capabilities, albeit collectively, followed by China and Japan.

Today rocket technology is not as captive as it was earlier. With the basic science fairly widely understood, it is almost just a matter of engineering to put together an effective space launch rocket. The issue today is to design and build reliable rockets that have a high probability of success and to reduce costs of each launch. The Soviet Union's successor state, Russia, today boasts of being the leading space-faring nation with the highest number of successful space launches. The USA has in the past few years suffered embarrassing technology setbacks that have led to the retirement of the Space Shuttle fleet and spectacular failures of its space launch rockets. USA has been reduced to importing rocket engines from Russia to maintain a minimum space launch capability and to book seats on Russian rockets to send astronauts to the International Space Station. In this context China boasts an enviable space launch record second only to Russia in recent years. The development of India's space rocket technology has been written about in detail during 2014. India has a well proven reliable workhorse in the PSLV and its variants. PSLV, however, is able to place relatively lighter payloads of about 2.5 tons into earth orbit. The GSLV variants are aimed at addressing this launch load shortfall. The GSLVs remain in development and are yet to notch up the success rates demonstrated by the PSLVs.

ISRO has announced that it now plans to test launch a RLV in March 2015. The RLV is likely to feature a single stage booster that will lift the vehicle aloft and impart a

Fully integrated GSLV Mk.III (LVM3) being moved to the launch pad at Sriharikota

First launch of GSLV Mk.III (LVM3)

speed of about Mach 3.0+. At this speed it would rise to an altitude above 100 km. Here it would carry out its mission of satellite release and then re-enter the atmosphere at high Mach numbers. It would now glide at speeds of up to Mach 5.0 or higher and finally land like a conventional aircraft on a suitable runway. The RLV could then, through attachment of a new booster stage, be reused, thus reducing costs of a launch through reducing the waste that results from rockets that are a one-shot vehicle with the entire vehicle being lost after a launch. At a later date, it may be possible to incorporate a supersonic combustion ramjet (scramjet) engine in the RLV to develop a powered vehicle with other utilisation possibilities. However, the initial RLV concept remains that of an unpowered glider once it detaches from the rocket booster used to launch it from a conventional rocket launch pad. Even the current concept of an initial RLV design is projected to be able to reduce the launch cost of satellites by ISRO by a factor of 10.At a later stage, ISRO could even emulate the American Space X concept of using a floating platform as a landing pad for the first stage of the RLV launch system.Successful recovery of the booster stage used to launch the RLV could reduce launch cost even further. RLV represents another challenge for ISRO and indicates that the organisation is looking ahead and thinking futuristically about useful technologies for the future.

The IRNSS is an innovative low cost solution to India's satellite navigation needs in both the civil as well as military sectors. IRNSS can commence operations with just four satellites though the entire seven satellite constellation will increase coverage and accuracy.The system can be scaled up to increase coverage from the initially planned area if required in future. It is expected that the year 2015 will see the IRNSS come on line once the planned satellite launches fructify.

ISRO has notable achievements to its credit in 2014. These include the Mars orbiter Mission (MOM) and the successful tests of the indigenous cryogenic engine and of the heavy lift GSLV Mk-III. Given the track record of ISRO's achievements so far, it is reasonable to be optimistic about ISRO achieving its declared programs for 2015.

Analysis of ISRO Technology Development

ISRO is, and remains, a purely civil organisation. However, the technology developed by ISRO could, in certain circumstances, be leveraged by the Government for national security needs as and when this is required. ISRO's satellite developments were initially designed and used for purely civil purposes before being utilised later for a few military applications such as remote sensing satellites being used for surveillance and communications satellites being used for limited military communications through hired transponders. From this point of view, ISRO's achievements till date and future plans bode well for India's national security. A few ISRO programmes have parallel effort in the defence domain from Defence Research and Development Organisation (DRDO).One such example is the development of scramjet engines for their own planned applications in the civil and military domains. India's effort to develop scramjet engines and hypersonic vehicles has also been written about. This is unique to India where the space programme was started as, and even today remains, a totally civil effort. In most other countries, including USA, Soviet Union, China etc., the national space programmes have a heavy defence tilt with civil uses being a spin off; in India the reverse is true with military applications being a spinoff of the civil space programme. India's system though often criticised domestically for this structure, could be said to actually be a better way of doing things. These concurrent civil and military technology development efforts by ISRO and DRDO result in a situation of each serving as a back up to the other. For instance, given that both ISRO and DRDO have achieved stable supersonic combustion in ground tests, at least one of these efforts should result in a working practical scramjet.

Even an unpowered hypersonic glide vehicle has obvious military applications when mated with a ballistic missile. Adding a scramjet to the vehicle only expands the possible uses of such a craft. It would be evident that successful development of a powered hypersonic vehicle could enable the country's aerospace forces to leapfrog an entire generation of aerospace technology to arrive at the state of the art for the next century.

And so, to space !

India has had an active space programme since the late 1960s. This programme has operated purely in the civil domain. In recent years, India's space programme has demonstrated its maturity through developing capabilities earlier owned only by technologically advanced countries. More importantly, India has demonstrated its capabilities through achieving feats that the others were unable to, at a lower cost and with higher success rates. The MOM is an outstanding example of this. Given the achievements till date, ISRO's declared plans to test the RLV and put the IRNSS into initial operation during 2015 are expected to add to its already noteworthy achievements.

Gp CaptVivek Kapur
Senior Fellow, CAPS

IAI MBT

Air Marshal Brijesh Jayal writes on

The Indian Aerospace Riddle ...

... where aerospace shines and aeronautics whines !

In its annual round-up of the best inventions that make the world "better and smarter," *Time* magazine has listed ISRO's Mars Orbital Mission, Mangalyaan as one of the top ones dubbing it the 'Super Smart Spacecraft'. As it records, "Nobody gets Mars right on the first try. The US didn't, Russia didn't, and the Europeans didn't. But on 24 September, India did". It further adds "A technological feat no other Asian nation has achieved. Building the craft cost India just $74 million, less than the budget for the film *Gravity*." Looking back, at the time the *New York Times* had similarly heralded ISRO's achievement under the banner "On a shoestring, India sends Orbiter to Mars on its first try" !

It is befitting that during those nail biting final moments of suspense when Mangalyaan was in the shadow of Mars and out of communications with its control centre and when none knew whether it would emerge successfully captured in Martian orbit or spin uncontrollably into deep space beyond, the Prime Minister of India was at hand to lend personal and moral support adding weight to his being dubbed as 'a technology-savvy Prime Minister'.

So palpable was the tense atmosphere within the mission control room at the ISRO head quarters in Bangalore that it seemed to hypnotise millions of ordinary citizens who were glued to their television screens. When success came, it was almost as if the entire nation had risen in a spontaneous cheer to mark not just success of the mission, but to applaud the very

Golden years : a single-seat HF-24 fighter leads a pair of two-seat trainers in formation

professional culture of ISRO and those within its fold.

Whilst the nation is fully justified in basking in the glory of this fine achievement in the field of aerospace, it is also a moment of reflection at where we stand on another facet of this challenging field of science and technology – that of aeronautics. This is relevant because in the academic, scientific and technological domains, aerospace and aeronautics are considered one discipline. The only difference being that whilst aerospace is associated with the spectrum of flight both in space and within the atmosphere, aeronautics is confined to flight within the atmosphere exclusively.

Speaking earlier this year to the Science and Society Programme on the subject 'Does India Have a Strategic Vision in Aeronautics?', Professor Roddam Narasimha, a highly acclaimed and eminent aerospace scientist and Honorary Professor at Jawaharlal Nehru Centre of Advanced Scientific Research, reflected on the 'paradox of aerospace' in India. Why, he wondered, can we boast of a world class space programme, a defence missile programme getting there, but when it comes to aeronautics, the senior cousin of rocket science, we fail to make it even at the national scene?

Nothing mirrors this paradox more starkly than the success of ISRO's Mangalyaan on the one hand, and the Defence Minister's recent statement in Parliament that HAL's inordinately delayed Intermediate Jet Trainer programme for the IAF still faced unresolved problems compelling the IAF to look at outside alternatives and that the delayed DRDO-led LCA programme will be completed by March 2015 instead of the December 2008 deadline set earlier! One can wistfully add that the programme actually commenced nearly three decades ago !

Historically, aeronautics in India has had a head start over aerospace. In the late fifties India had indigenously designed a jet fighter the HF- 24, being one of the very few countries in the world to have done so then. India had also designed the HT-2, a basic trainer and the Kiran, an intermediate jet trainer. All these aircraft were produced in quantity at Hindustan Aeronautics Ltd and served the IAF well. The Kiran still continues in service and till recently the IAF formation aerobatic team *Suryakirans* was demonstrating it to great acclaim in international air displays.

Dr Vikram Sarabhai, father of India's space programme

Even as these giant steps were being taken in the aeronautics field, we were beginning to attempt the first baby steps in aerospace with scientific investigation of the upper atmosphere and ionosphere through small sounding rockets. Back then, whilst there were no impediments to our advance in the field of aeronautics, even these modest aerospace activities drew criticism with negative voices questioning the relevance of aerospace activities to a developing country like India. It is to the credit of Dr Vikram Sarabhai that he was able to prevail upon then Prime Minister Nehru of the potential of space technology into the future. Since, in Prime Minister Nehru the nation had a leader who passionately believed in science and technology playing a crucial role in the country's social and economic future, the naysayers were silenced and aerospace received the necessary political, financial and moral support.

Dr. Sarabhai's vision and its dogged pursuit have rightly earned him the distinction of being called the 'Father of Indian Aerospace'. Equally in a tribute to Pandit Nehru's sagacity and aerospace vision, *Chandrayan 1*, the first Indian built object to reach the moon's surface did so on his birthday on 14 November 2008, with the Indian tri-colour painted on the sides of the Moon Impact Probe (MIP), one of the payloads on board.

But beyond being a visionary, Dr. Sarabhai was also a pragmatist and recognised that to harness the potential of aerospace, scientific and technological challenges could only be overcome if backed by a sound organisational and management architecture. According to Prof Roddam Narasimha, Dr. Sarabhai had in 1970 proposed to the Administrative Reforms Commission, an organisational model with a Ministry of Advanced Technologies comprising of separate Commissions for Atomic Energy, Space, Earth Sciences *and Aeronautics*.

It speaks for his foresight that today we have independent departments for both Space and Atomic Energy with their respective Commissions and a ministry for Earth Sciences also with its Commission. In all these fields the nation is second to none, keeping abreast with the international community. But the one other field of advanced technology that Dr. Sarabhai had identified, namely aeronautics, remains a technological orphan with neither a Department nor a Commission to steer it strategically to bring it at par with other industrialised nations. Instead, aeronautics has remained relegated to the folds of the Ministry of Defence being driven primarily by its operational needs as they evolve from time to time.

Successful aeronautical nations have invested heavily in promoting a culture of robust research, design, industrial and management capability that allows new and innovative ideas to flower into better and more efficient systems through developing new technologies in laboratories, transferring them for economically viable products and, integrating and testing them towards providing better platforms and systems for not just their domestic needs, but for the international aeronautics market as well. To make this challenging task economical and competitive such aeronautical activities need a significant degree of national oversight, coordination and support, which their governments amply provide.

That a separate Ministry or Department along with a Commission for aeronautics stubbornly eludes us, inspite of the success of this model in the other fields as recommended by Dr Sarabhai and being supported by various expert groups over subsequent years, remains an abiding mystery. Rather than aeronautics being driven by a long term strategy which has within its scope not just military requirements, but those of civil and general aviation, R&D, aeronautical industry both public and private along with its wider contribution to national economy, it has become confined to the limited need of fulfilling the immediate requirements of the armed forces. Not surprisingly this model has resulted in the Indian aeronautics sector being largely crisis driven and import dependent. It needs no rocket scientist to conclude that this one weakness is single handedly contributing to the paradox that Prof Narasimha alludes to, whilst also answering in the negative his larger poser of whether India has a strategic vision in aeronautics.

India not only has the dubious distinction of being the world's largest arms importer, it has in recent years

ISRO has succeeded in launching scores of satellites into orbit

imported close to $10 billion worth of airborne platforms from the US alone, not to mention the continuing imports from Russia. Except for the vintage Kiran trainer and the more recent Dhruv helicopter, every other airborne platform in service with the IAF, the fourth largest in the world, is an imported design. It is estimated that there are over two-dozen such imported platforms in service of the armed forces. Further, operational and maintenance costs of a fleet during its life cycle approximate to roughly to twice the initial procurement costs. With no strategy or plan to nurture micro, small and medium sized enterprises that will specialise in airborne parts and systems, we will continue to remain dependent on imports to keep our platforms airworthy long into the future.

It was President Eisenhower who in his farewell speech cautioned his people of the unwarranted influence of the military-industrial complex and its potential for the disastrous rise of misplaced power. One sometimes wonders whether neglect of aeronautics in India is actually borne out of any such unwarranted shadowy influences?

There are other areas where there appear stark differences in the aerospace and aeronautical fields in India. Congratulating the scientists and engineers the PM recently complemented ISRO for cultivating the culture of progressively nurturing young talent in line with our ancient *'guru-shishya parampara'* and exhorted all to push boundaries further.

In contrast, whilst addressing an award giving function of Defence Research and Development Organisation scientists, prior to this event, the PM was less upbeat, exhorting the scientists of the value of time and timely completion of projects telling them the world will not wait for us. Explaining that India did not lack a talent pool, he cautioned them about a *'chalta hai'* attitude. Undoubtedly delayed projects like the LCA, amongst others, were certainly weighing on his mind.

He further advised the scientists to give more responsibilities to the youth even suggesting that in five of DRDO's fifty-two labs, only those below thirty-five years of age should be vested with decision-making powers. What perhaps prompted these observations has only become evident by later reports of the practice prevalent in DRDO of a Departmental Peer Review Committee granting extensions to fellow scientists. Reportedly fifteen top DRDO scientists were on extension with six to eight getting extensions every year.

This is proof, if any were needed, of the bureaucratic inertia that plagues the very culture within DRDO and of the archaic non-functioning model of defence research in aeronautics. Not surprisingly this top heaviness has been resulting in heavy attrition amongst the younger DRDO scientists at an average of one hundred per year. In sharp contrast, former ISRO Chairman Professor UR Rao was quoted as saying 'Achievements like the Mars Orbiter Mission would attract graduates to ISRO. You need passion to work in ISRO. That's why people who join the organisation seldom leave it for another job.'

This writer is reminded of a time in 2006, when within a span of a few days ISRO's launch of a GSLV rocket and DRDO's launch of an Agni 3 missile, both ended in failures. Since failures are part of the business of research and development, every dynamic aerospace institution is expected to be prepared for such an eventuality and emerge wiser and stronger. ISRO accepted the failure in a press conference, promised to investigate and announced its determination to re-launch in a year. DRDO on the other hand ducked and offered no public comment. It was left to the Raksha Mantri to later state that the test was a partial success, leaving the public guessing on what this really meant! At the time, in a column in a national daily this writer had compared the approach of the two institutions. Of ISRO one felt 'it is this spirit that differentiates the men from the boys' and of DRDO 'this is not how serious nuclear powers go about testing their front line delivery systems'. Eight years on, nothing seems to have changed!

Judging by his exhortations to those at ISRO and DRDO, clearly the Prime Minster has got the feel of the scientific, professional and cultural pulse of these organisations and the wide gap that exists between their ethos and indeed performance. That the government has scrapped the Department Review Committee of DRDO also is a pointer that perhaps for the first time after PM Nehru with his vision for science and technology, we have another Prime Minister with a keen eye and feel for what science and technology can do for the future of India and is willing to take bold steps towards the nation achieving its potential. In such an endeavour there can be no holy cows.

In countries with advanced aeronautical industries, the primary driver of R&D has been the military. As technologies then mature and become commercially viable they find application in civil aviation and other fields. It follows that if Indian aeronautics aspires to compete with the aeronautical majors of the world, it must be backed by robust R&D and industrial support, which in turn must be driven and initially funded by the Indian armed forces with both public and private sector institutions adding their weight. Whilst this calls for a high degree of professionalism and synergy amongst all the stakeholders, it also needs a unique management and organisational model, which cannot be provided by a Government Department like the MoD. Lack of institutional teamwork, resulting in separate interests and lobbies has been the unpleasant reality and soft underbelly of management of aeronautics in India.

Lately, on the launch of Prime Minister's 'Make in India' campaign much has been heard from the MoD on its determination to follow this route with vigour. One hopes that the MoD recognises that in many ways the aeronautics business is unique and mere platitudinous changes to procurement, offset and allied policies and procedures will have little impact on the ground unless these are built on strong foundations arising out of a larger national strategic vision for aeronautics. This vision must start from grass roots upwards and not be driven from the top through superficial clichés like 'Buy and Make'.

India has the talent and capacity to both partner on equal terms and compete with aerospace majors of the world. All it needs is the will to harness its collective resources, evolve a long-term strategy and execute this productively. With a technology savvy Prime Minister in the captain's seat and an IIT engineering graduate as his Defence Minister and copilot, there is growing optimism within the aeronautics fraternity that the government will display the sagacity to heed Vikram Sarabhai's advice and give Indian aeronautics the organisational and management model steered by an Aeronautics Commission and backed by a Department of Aeronautics that has long been its due.

The riddle of Indian aerospace will then be a thing of the past.

Air Chief Marshal Arup Raha on

Aerospace Power in the 21st Century

The annual 'Jumbo Majumdar Seminar', in addition to paying tribute to an Indian Air Force legend, also deliberates on many air power issues of contemporary relevance. The topic 'Conflict and Aerospace Power in the 21st Century' was highly relevant, especially as we are currently witnessing a significant process of evolution in the nature of conflict as well as in the expanding capabilities of aerospace power. Some excerpts from the CAS's talk!

Karun 'Jumbo' Majumdar in cockpit of RAF Typhoon in 1944

Jumbo Majumdar was the IAF's first World War II hero and, in fact, the only IAF pilot to be decorated with a bar to the DFC. He was one of the pioneers of the IAF's operational experience as it was under his command as a young 28-year-old squadron commander of No. 1 Squadron, that the IAF operationally cut its teeth. Barely had his squadron of 12 Lysander Army Cooperation aircraft deployed at Tungoo in erstwhile Burma, when Japanese bombers operating out of the occupied aerodrome at Mae Haungsaun in Thailand carried out a large force raid. Fortunately, all the Lysanders were well dispersed and there was no damage either to the men or the aircraft.

Notwithstanding the fact that Lysanders were basically reconnaissance aircraft, Jumbo Majumdar had made up his mind to respond in equal measure to this Japanese provocation and he earnestly got on to the task of improvising the Lysander for the bombing role. A bomb rack was improvised and two 250 lb bombs were fitted on it. So impressed were the New Zealanders deployed there with Jumbo Majumdar's courageous spirit that they sent their Buffalo aircraft as escorts. Jumbo Majumdar flew over dense forests and jungles of the intervening mountain ranges and struck the Japanese aircraft hangar and wireless station with deadly precision, causing extensive damage to the hangar and the aircraft. After such an audacious display of the 'never say die' spirit of the IAF, Jumbo Majumdar promptly declared that his squadron would henceforth also function as a 'bomber squadron'.

Increasing Relevance of Aerospace Power

The IAF is proud of such a legacy of visionary leadership, innovation and pioneering spirit and it is this inheritance which has helped us in weathering many of the past and present day transformational challenges. The IAF is in the midst of a comprehensive modernisation plan, which will enable us to acquire niche operational capabilities essential for handling our future national security *contingencies*.

Air Chief Marshal Anup Raha, CAS/IAF

As conflicts continue to evolve, we correspondingly see aerospace power rising up to each and every emerging challenge in equal measure. I firmly believe that the future will witness the continued preeminence of aerospace power as the primary instrument of choice for almost all operational contingencies. Aerospace power is only 110 years old and despite being the youngest of the three elements of military power, it provides immense relief and freedom from surface friction which is inherent in any army/naval operation. So while the 20th century belonged to air power, the 21st century certainly belongs to aerospace power.

The history of nations clearly highlights the fact that for a state to become a great power, it is imperative that it demonstrate mastery over the creation, deployment and use of military power towards achieving national objectives. And amongst the three Services, it will always be the air force which will afford prompt multiple response options to the political leadership in times of national security crises.

IAI Elta

Pair of Mi-17V5s, bearing the IAF ensign, at an Air Force Day parade (photo : Angad Singh)

Recent conflicts have clearly demonstrated the resounding success of aerospace power because of its ability to simultaneously interface as well as influence land/sea operations. The relevance of aerospace power, in fact, has increased manifold over the years – it is the ultimate weapon for assured victory in a conflict. And it is for this reason, therefore, that there is a clamour for an enhanced 'air wing' of the army and navy, as well as of the paramilitary forces. It is due to this realisation of the paramount importance of aerospace power that nations have treated their air forces as their best form of defence and deterrence.

The Nature of Conflict

I will briefly touch upon the nature of conflict as we see them and look at the evolution of aerospace power, particularly in our context. Then I will spend some time tracing the future contours of the growth of aerospace power, where I will talk about some of the associated challenges. I will also put forward some future propositions on the employment of air power.

When we talk about conflicts, we find that very often, war and armed conflicts are treated as near synonymous terms. With the blurring of boundaries among peace, war, armed conflict, conflict and terrorism, the transition from one to another is increasingly becoming less and less well marked. Armed conflicts embrace a wide range of conflict situations in which the armed forces may be required to operate and may encompass the entire spectrum. The dimensions and character of any particular conflict would, however, depend on a variety of factors ranging from the degree of national interest involved; the nature and the extent of limitations imposed; the character of forces engaged as also the level of intensity; and the duration.

The causes of conflict

The 21st century geopolitical environment will continue to be characterised by constant changes and upheavals. Despite the existing unipolar world order, new power centres will continue to constantly emerge and these, in turn, will necessitate realignments. To my mind, there are several predisposing factors which will govern the changing nature of future conflicts.

- Firstly, there would be an ever increasing contest over limited resources, be they energy, food or water.
- Secondly, notwithstanding the increased cooperation which is dictated by the nature of the globalisation process, there would still be certain conflict points arising out of comparative asymmetry amongst the stakeholders. This asymmetry would be based on economic strengths and vulnerabilities, technological or scientific growth with mastery over critical technologies like metallurgy, engine-propulsion, space and cyber applications, Electronic Warfare (EW), nuclear, etc; and, more importantly, the differential in the capabilities of the defence forces of the stakeholders.
- Thirdly, there would be the ever present threat posed by the extremist non-state actors, quite similar to what we have been witnessing in our neighbourhood, resulting from perceived or real grievances.
- Fourthly, all future conflicts, be they inter-state or intra-state, are likely to involve ethnic, religious or cultural issues individually or as a combination of factors.

Saab

In this respect, lack of economic growth or inadequate development of human resources, and deprivation and exploitation of economically weaker sections would result in social unrest, upheaval, insurgency and conflicts, into which the armed forces may get drawn for maintaining law and order, peace and tranquility.

will be a need to address each new conflict on its own specific merits.

But despite these new demands, the armed forces would still be expected to meet the classic objectives which will include deterrence, coercion, denial, destruction and disruption. Hence, the armed forces need to continuously and proactively monitor the

mind is the primary attribute which will ensure the continued primacy of aerospace power amongst the range of available sovereign options. It is also my belief that it will be air power's ability to maximise its comparative advantage in the third and the fourth dimensions and to dominate the information space that will underwrite

IAF's C-130J-30 'special ops' transport aircraft (photo : Angad Singh)

● And lastly, cyber security or the cyber domain is the new dimension of conflicts between nations. Cyber war could cripple a nation's functioning and bring it to its knees without the use of arms or violence. So, with such an abundance of predisposing factors, it would be safe to assume that conflicts will continue to arise in the future.

Role of the Armed Forces

The question, therefore, is that given the present dynamic conflict environment, what will be the role of the armed forces? Although the probability of full scale mobilisation and total wars is diminishing, the armed forces will certainly need to remain prepared for addressing asymmetric conflicts and terrorist threats. With demarcations blurring, there

security environment and remain prepared to tackle the contingencies, as and when they arise.

Aerospace Power : Its suitability in the present context

Amongst all the other elements of military power, aerospace power is perfectly suited to handle this dynamic requirement as its inherent flexibility allows it to capitalise on the often narrow response timeframes. Air and space capabilities afford the much needed political freedom of manoeuvre by enabling us to exert influence in a sustainable and easily scalable manner, while, at the same time, limiting our own political liability by reducing our footprint on the ground. This, to my

its future utility as a useful, credible, viable and essential tool in both the influence any nation can exert in international arena as well as the hard elements of national power.

Aerospace Power and Affordability

Let me now address the commonly held perception that in the present era of austerity and ever tightening purses, aerospace power will be an expensive capability to maintain and this characteristic will, in turn, prevent its continued growth. Yes, the upfront cost of an aerial platform may be higher as compared to other combat elements, but this, when set against the value brought throughout its effective lifespan, certainly makes it a wiser option.

Boeing Defence Ad 2

Force Structure

While addressing our modernisation requirements, when we deliberate on the right force structure, we need to understand our priorities clearly, so that we can wisely allocate our scarce resources. At the same time, it must also be understood that resource availability alone should not be allowed to dictate our force structure to such an extent that we lose the capability to dominate the air, as this would certainly prove to be much more costly in the long run. The force structure, therefore, must provide the best value for money. With the people and their training. Our training domain is an important Key Result Area (KRA) for us and we have instituted many long-term initiatives to streamline it even further.

Importance of Information Warfare

Information technology in recent times is being recognised as a key to warfare. Developing space and cyber warfare capabilities will require a well thought out and a time-bound implementation plan. The IAF will remain at the vanguard of contingency where aerospace power will not be employed, be it for control of the air, situational awareness, advanced Intelligence, Surveillance, Reconnaissance (ISR) and precision strike capability or in other cases even for supporting any surface based operation by providing tactical and strategic transport support.

My second proposition concerns the scenario often painted by some experts outside the aerospace fraternity that we are presently witnessing the last of manned aviation and here onwards, unmanned platforms would rule the skies. Let's assume

Air dominance : IAF Su-30MKI seen flying over rugged terrain

future being as unpredictable as it is – we need to remain prepared for a full spectrum response and, hence, the IAF needs to ensure that we build as much adaptability and multi-role capability into our force structure as possible. Our focus must rightly shift away to delivery of capability rather than individual platforms.

Quality

Another important point about affordability concerns the question of quality. We must understand that the aspect of quality, especially in the realm of aerospace power, can never be compromised – not only in our equipment which has to be state-of-the-art but, most importantly, in our development of India's space and cyber space, and, hence, it is best suited to steer the future exploitation of our joint capabilities. As an organisation, in addition to focusing on platforms and weapons, we also need to address the information domain as a key force multiplier.

Some Future Propositions

At the end, let me now put forward some future propositions about aerospace power and its continued relevance in the 21st century. To all air power enthusiasts, I can confidently say that despite constrained resources, there is no need to worry about the future growth of aerospace power. I do not foresee any future operational for a moment that we fully automate the air transport role as these are in any case being flown virtually autonomously for most part of their mission. The big question, of course, is how many people would prefer to entrust their safety entirely to machines? Similarly, if we look at automating the combat platforms, we will need to be clear in our minds whether we are ready to devolve life and death decision-making authority entirely to machines. It will be wrong to take the human element totally out of the loop and rely only on data-links and satellites. It is precisely these factors which will ensure that manned aircraft will continue to operate for a very, very long time in the future.

BAE System

Where the Mind is Without Fear ...

Air Commodore KA Muthana in first flight of Tejas SP-1

A Viable Ecosystem for Development of Aeronautics

This is an examination of what constitutes a viable ecosystem for development of aeronautics, from the perspective of a test pilot. What is an ecosystem? A definition of a biological ecosystem could be "a biological community of interacting organisms and their physical environment that work together to remain healthy." Business ecology is based on the elegant structure and principles of natural systems. It recognises that to develop healthy ecosystems, leaders and their organisations must see themselves and their environments through an 'ecological lens.'

If any plans exist for building an aeronautical ecosystem in this country, I hope that such plans will be implemented soon. If a plan does not exist, it is high time that we make one. Once an ecosystem is made, its healthy sustenance will depend on the ethos adopted for its functioning. I would like to suggest one: from a 'make in India' effort, I have chosen a 'made in India' one.

There is that famous poem by Rabindranath Tagore 'Where the Mind is Without Fear', published in the year 1910, that reads thus:

Where the mind is without fear and the head is held high;
Where knowledge is free;
Where the world has not been broken up into fragments
By narrow domestic walls
Where words come out from the depth of truth;
Where tireless striving stretches its arms towards perfection;
Where the clear stream of reason has not lost its way
Into the dreary desert sand of dead habit;
Where the mind is led forward by thee
Into ever-widening thought and action;
Into that heaven of freedom, Father, let my country awake.

It would be revealing if one did an introspection of the functioning of our organisations, and arrived at one's own conclusions on the extent to which such 'freedoms' exist. Some of the questions could be: is the mind of every constituent of our organisations without fear of unfair retribution and are they able to hold their heads high? Aside from IPR, is knowledge really free flowing or do we always keep something up our sleeve? Are we fragmented in our approach to nation building and is there national visionary leadership capable of breaking narrow domestic walls? Are we capable of timely revelation of truth of an adverse nature? Are we capable of telling the whole truth? Or are we telling half-truths which cloud the essence and make us incapable of either seeking or being given help? Are each of our constituents tirelessly striving towards perfection or misusing rules to while away time? Are we capable of

questioning the status quo and change, not for the sake of change but to rebalance a shaky ecosystem? Are we motivating each of our constituents to ever widening thought and action or are we telling them "not to question why" but "to do and die?" The ethos that this poem suggests is fundamental to a thriving ecosystem. Its adoption and spread is a function of leadership and not of management. We need to lead more and manage less.

Dilemma of the armed forces

As enshrined in the Joint Doctrine of the Indian armed forces, "the national aim of India is to create an internal and external environment, conducive for unhindered economic progress and socio political development to enable India to assume its rightful role in the emerging world order." The armed forces are expected to contribute to the shaping of India's 'internal and external environment.' A prevalent thought in the armed forces, therefore, has been to say, "I do not particularly care where my equipment comes from, but I want the best that the money I have can buy." While eminently defensible in a bygone era, is it defensible today? I have been involved in almost every recent major fighter aircraft upgrade and development programme in this country. My experience of contracts with foreign vendors is that almost every programme had run into trouble with contract issues, product support issues, transfer of technology issues and so on. At the same time, domestic players promise the moon, but do not live up to expectations. The present plan should be to buy just enough to keep our teeth sharp, while going hammer and tongs, to force all players to "make in India". An ecosystem that supports this philosophy will not only enhance security but also contribute to economic progress of this country.

Mix of combat aircraft types operated by the IAF today : MiG-21, Jaguar, MiG-27, Mirage 2000, MiG-29 and Su-30MKI : these are to be supplanted by the LCA, MMRCA, AMCA FGFA in the next decades

Definition of needs

There apparently is general consensus on the leadership role of aviation in driving technology in the country. But there are so many overlapping aircraft programmes. It is perplexing and mindboggling! In addition to numerous outright purchase programmes, there are the Avro 'replacement', RTA, MTA, BTA, IJT, AJT, LCA, AMCA, MMRCA, FGFA, US-2 and a multitude of helicopter and unmanned aircraft programmes.

There are also varying plans for the Army Air Corps, Naval Aviation, Coast Guard Aviation and of course the Air Force itself. If all are necessary for India to assume its rightful role in the emerging world order, then so be it ! But on a serious note, the Government being the largest consumer of these products, must publish a 'white paper' on its perspective of the needs of civil and military aviation sectors in India, so that there is a clear focus and the relevant ecosystem remains healthy.

Need for leadership in the political domain

A white paper such as the one mentioned above can only be created in India by active and decisive leadership in the political domain. Inter-departmental and inter-ministerial priorities and rivalries simply will not permit emergence of a cohesive paper without firm political leadership and direction. National consensus can

Members of an earlier LCA test team seen with LCA PV-1 (KH2003)

be attempted in parliament so that the plan remains above partisan politics. Establishment of a National Aeronautics Commission under the PMO with executive authority to enforce the white paper is an essential step.

Management of flight test crew

In a country of 1.3 billion people, these are less than 100 flight test pilots and engineers ! Undeniably strategic assets, these personnel must be treated and used as such. Our greatest success in aeronautics has been the Light Combat Aircraft and it was acknowledged by the Air Chief himself that continuity of test crew in the programme has paid rich dividends. Unfortunately, even today we do not have a grip on how to produce enough of the right quality and use them properly. Test crew must be allowed to permeate every aspect of design because, if not in depth, they have the largest volume of knowledge in the aviation world enhanced by their ability to think in the third and fourth dimensions.

Management of flight test infrastructure

These fall into two categories: terrestrial and spatial. Terrestrial could be further subdivided into airfield infrastructure and Flight Test Instrumentation (FTI) infrastructure. Ideally airfield infrastructure must be close to development facilities and industry. The only airfield actively engaged in development flight-testing in this country is the HAL airport at Bangalore. Unmitigated construction around the airfield and resultant deterioration of the environment means that disaster is just waiting to happen.

As far as FTI infrastructure is concerned, there are about a dozen telemetry stations within a radius of three kilometres of HAL airfield. Can we rationalise, modernise and timeshare? Spatial infrastructure can also be subdivided into two: airspace and airwaves. There are two test-flying areas in the country, one supports flying out of HAL Bangalore and the other out of HAL Nasik. The former has already been encroached upon and the latter is being sought to be encroached upon. One can rarely hope to execute a high risk test point or execute a Mach run in Bangalore without one's concentration being disturbed by interference from air traffic control. An all-new dimension that will complicate the situation further will be added when we start flight-testing the larger UAVs.

In contrast, even a fly cannot enter Area 51 in the USA, a country with a far denser air traffic environment. Sanctity of test flying area in time and space must be restored and sustained. HAL, as controller of the test flying airspaces in the country must be constituted into the National High Level Airspace Policy Board. With respect to frequency allocation for telemetry, NFTC has been made to run from pillar to post for more than two years by the Wireless Planning & Coordination (WPC) Wing, but to no avail! Even a direct request from Secretary to Secretary across ministries failed to elicit a response. So much for the existing ecosystem!

HAL rotorcraft development projects, such as the ALH and LCH (pictured here) have been reasonably successful

Desired technology levels

When we design a strategy for indigenous development of futuristic civil and fighter aircraft, there are many issues that need balancing. The ecosystem cannot exist in a vacuum. It is important to understand what contemporary world class is, in which direction research is heading, and what our ambitions for market access are. Without such understanding, our products are likely to be crippled on the drawing board itself. Having understood and accepted the present, decisions will have to be made on whether to go for high-end ab-initio projects or plan a graduated up-scaling. There has to be a balance between 'brochure-based' demand from the end user and constant whining of the designer as to why the user wants a particular capability. If one is unable to understand a requirement, one must have the wisdom to accept a requirement from

LCA taking off during a display flight at Aero India 2013 (photo: Angad Singh)

experts in the field. For example, it has been found hard to explain to designers why fusing of sensor information at the display to provide immediately actionable intelligence is as important if not more than achieving sensor fusion at the acquisition end.

Next, our plans in the defence arena must factor in the necessity to enable our platforms to plug into other indigenous systems such as IRNSS and Gagan. On a related note, while we are discussing development of futuristic fighter aircraft, we must remember that fighter aircraft are useless without sensors and weapons. While one may consider sensors as organic to a fighter, the same is not necessarily the case with weapons and, therefore, development of weapons must go hand in hand. Our focus on development of smart air- launched weapons has been weak and integrating foreign weapons will always be suboptimal.

The civil aviation sector also needs an augmentation of safety and certification bodies

Unified certification, licencing and investigating authority

CEMILAC (Centre for Military Airworthiness and Certification) is a military body, as the name suggests. DGCA is an office of the Ministry of Civil Aviation and a regulatory body primarily dealing with aviation safety issues. While ad hoc arrangements may exist, there is no apex civil certification authority that is capable of mentoring a developer towards civil certification. A unified body that can share knowledge and experience must be constituted under an Aeronautics Commission. There is also a need to develop a pool of this critical specialisation. Similarly, there is no system in existence to licence civil test aircrew to fly military registered aircraft even though such practice exists and must be formally enabled. There is also a need to form a National Air Transportation Safety Board under the suggested Aeronautics Commission, to investigate accidents and incidents that are outside the authority of the Armed Forces.

Professional and empowered project managers

Often touted as one of the weakest areas in the Indian context, there is no reason why this must be so. Firstly, it must be recognised that this is a major problem area. Only then is there hope of movement towards a solution. We generally have 'accidental programme managers' who fall into this position from elsewhere and then blunder along. They may not be adequately empowered with executive and financial authority and remain mere coordinators. Today, programme management is a professional career and these professionals come suitably armed with powerful tools. Suitably talented programme managers who are young enough to see the end of a project must be entrusted with and empowered to run programmes, while the older ones are moved to mentoring roles to ensure that experience is also brought to bear. Unlike life, this is about the destination and not the journey!

Concept of national teams

This was a unique concept in the Indian context, conceived by Dr Abdul Kalam. He brought together nationally available talent to form centres of excellence such as the National Control Law Team and National Flight Test Centre, which have been unmitigated success stories and continue their contributions to this day. There must be no hesitation in constituting, for example, a National Engine Team or a National Navigation Team as centres of excellence in their respective areas of specialisation, whose products can bring everlasting value to this country since they will be essential even beyond manned aviation. Similarly, if any element of the aeronautical ecosystem runs into trouble, national resources can be brought to bear in its aid.

In conclusion, it should be clear that while evolving a strategy for indigenous development of futuristic civil and fighter aircraft, an initial step must be to conceive an aeronautical ecosystem and create its elements, or reconstitute existing elements into the ecosystem. The essence of functioning of the ecosystem must be to retain all constituents in good health. The time for talking is over and we need to start walking !

Air Commodore KA Muthana VSM (Retd)

Adapted from his Dr Neelakantan Memorial Lecture at the 65th Annual General Meeting of the Aeronautical Society of India.

UAVs in India

Heron

The need for aerial surveillance capabilities was realised after the Kargil border war of 1999. Absence of effective aerial surveillance delayed Indian response and lack of real-time intelligence and reconnaissance rendered counterattacks and artillery fire difficult.

Although the Nishant was already 'in the pipeline', the system was not mature enough and ready to deliver the performance required by the Army. It took the DRDO 16 years before the first system was declared operational with the Indian Army.

Indian interest in unmanned aerial systems (UAS) had begun in the early


Searcher-II

1980s, the first concept to mature into a programme being the Nishant, as awarded by the MOD to the Defence Research & Development Organisation (DRDO) in 1988. Nishant made its maiden flight seven years later, in 1995. The Army was impressed, and planned to field at least 12 systems to support its Divisions in the field.

To enable this drone in getting airborne and sustain operations, the Nishant is designed for catapult launch and retrieval by parachute, cushioned by an airbag. While these functions enable deployment from unprepared sites they also expose the drone to excessive wear and tear, owing to the impact of parachute landings.

Indigenous Technologies

While the Indian armed forces inducted the Israeli Searcher and Heron UAVs with their proven reliability and maturity, the DRDO continued to develop its indigenous unmanned systems capabilities, as part of the national objective to attain self-reliance in this important field. Primary areas of development are UAS ranging from miniature to large. The Aeronautical Development Establishment (ADE) is the nodal agency in DRDO responsible for UAS development and the Establishment is developing low speed long endurance types and high-speed systems, which include pilotless target aircraft and cruise vehicles.

The most significant milestones have been first flight of catapult-launched Nishant in 1995, first successful flight of Rustom 1 and Netra multi-rotor quadcopter

The Golden Era – Indian use of Israeli UAS

Heron

The Indian armed forces have well realised the need to close the airborne ISR 'gap' as massive fielding of UAVs require the procurement of operationally proven systems. When this requirement was sought to be met, only Israeli systems were both combat proven and available. The Indian interest combined with Israel's willingness to sell such advanced systems ignited the spark followed by the influx of unmanned systems of different types, supporting Indian military branches and national security agencies.

At first, Israel supplied Searcher Is, as the system began phasing out of service with the Israeli Air Force, which was followed by Israel Aerospace Industries (IAI) Searcher II that was publicly presented during the 2005 Republic Day parade. By 2006 India's armed forces had nearly 100 UAVs in service. Many Units operated mixed formations of Searcher II and Heron I, enabling users to benefit from extended mission endurance, and task-specific payload configurations, supporting a wide range of missions and applications. This massive induction of UAS propelled India to becoming one of the world's largest UAV operators.

Although these UAS were imported from Israel, the systems are fully supported in India, by a joint-venture company established between IAI and HAL. Cooperation is also underway regarding payloads, operators training and support. Operationally, the Israeli UAS have demonstrated excellent readiness and reliability. According to IAI, the mission readiness of the Heron fleet that has recorded over 300,000 operational flight hours with 20 customers is over 95%, far above the average availability of manned aircraft. One of the attributes of the system's safety and performance is automatic takeoff and landing, eliminating the need for an 'external pilot' (the human control on takeoff and landing found to be the cause of many UAS related mishaps).

The numbers of Israeli-origin UAS operating in India is expected to grow further, with the introduction of new UAS units and expanding the missions of existing formations. The Indian Army plans to field UAS units supporting every battalion of the Mountain Strike Corps; the Indian Navy plans to expand its inventory, operating drones with four units, performing maritime search and coastal security. The Indian Air Force is also expected to expand on use of UAS, with the induction of drones capable of carrying heavier payloads, for long missions. More systems are expected to have satellite communications, expanding the use of drones in mountainous area or over the sea. Improved payloads and datalinks also mean these drones will be able to deliver video, thermal and radar imagery at higher fidelity and enhanced real-time intelligence to support users.

Among the Israeli drones reportedly being considered are the Super Heron and Heron TP from IAI. Beyond the systems, IAI is also offering new mission payloads, including electro-optical payloads and datalinks supporting new high-definition standards in the visual and infrared bands. Other payloads would also include signals intelligence, synthetic aperture and surface search maritime radars for maritime surveillance.

in 2010. During 2014, the DRDO marked several evolutionary milestones with its UAVs, with first flight of the 'Imperial Eagle' mini-UAS, and first conventional take-off from a runway of a wheeled version of the Nishant, called Panchi. The most significant programme is the Rustom II Medium Altitude Long Endurance (MALE) drone, which carried out taxi tests in 2014. Flight-testing is planned and will take place in 2015.

with real-time reconnaissance and force protection. In addition, artillery regiments are also operating tactical drones that provide real-time target acquisition, fire direction and battle damage assessment for artillery formations. The Army has considered several tactical UAS development programmes carried out under cooperation between ADE and Israel Aerospace Industries (IAI), based on IAI's I-View programme however, these have not yet reached maturity.

capacity. Among these are the electrically powered Panther tilt-rotor UAV from IAI that can carry 8.5 kg of payload on a 4 hour mission, or the Birdeye 650D, that carries a payload of 5 kg on a mission that can last 24 hours. Another system likely to fit the requirement is the Boeing/ Insitu RQ-21 Integrator. The company is also promoting the Scan Eagle in India, a drone uniquely fitted for operation from naval vessels.

Harpy

The Indian Army is also seeking to expand the use of drones at the tactical level, planning to field a number of miniature UAS in support of battalions and brigades in the field. At these levels, UAS are required to operate as organic assets, supporting units

As decades have passed and technologies improved, the Indian Army can now benefit from far improved capabilities. Foreign developers are now offering small, tactical UAS with much longer endurance or improved payload

The tactical UAS category currently in service supports division level operations, which includes drones such as Searcher II (or Panchi) that cannot advance with the forces, as they require runways and considerable logistical support for continued

IAI Malat

operation. Contemporary electrically-powered miniature UAS, particularly those designed for vertical take-off and landing such as the Netra multirotor and IAI Panther tilt-rotor drone, enable deployment in the field by tactical forces and such drones can well be deployed with lower echelons. They are particularly useful in support of forces operating in crowded urban areas or in the jungle, where buildings or vegetation hinder safe landing. Electrical propulsion also means such mini-drones remain effective even when operated in mountainous terrain, at altitudes that would prevent efficient operation of small internal combustion engines. The low thermal and audible emission means these drones can operate virtually unnoticed by the enemy, particularly at night.

The Indian armed forces are also interested in more conventional mini-UAS, one of which is the RQ11 Raven B, developed by the US company Aerovironment. During his recent visit to India, US President Barack Obama reportedly discussed the prospects of such mini-drones to meet Indian military requirements. Under the renewed bilateral Defence Technology and Trade Initiative (DTTI), India and the USA will reportedly develop an enhanced version of the Raven to offer longer mission endurance (up to six hours) and extended range (up to 18 km). The opportunity is likely to follow an agreement for local manufacturing of UAVs, which was signed by Dynamatic Technologies and AeroVironment Inc. in 2013.

The collaborative development of mini and Micro UAS is based on India's existing activity in this field, since Indian SMEs, primarily private sector enterprises, have been developing such systems for several years. Such innovation is made more attractive owing to potential civil application of the UAS, access to technology, and prospects for export, encouraging investors and entrepreneurs to invest in UAS technology.

Netra mini-quadcopter, developed by Bangalore-based IdeaForge is another such system, which has supplied systems to the DRDO as well as to a number of military and law enforcement users. Among the applications for these drones are for wildlife preservation, public safety and law enforcement over crowded urban areas with aerial reconnaissance used as first response in emergency situations. Despite the clear advantages of such means, UAS operations in civilian managed airspace is still limited by lack of regulatory control, given the potential risks UAS pose to flight safety.

Drones with a Punch

Intelligence Surveillance Reconnaissance (ISR) is a 'must have' capability for armed forces today and as China develops a comprehensive range of unmanned systems carrying offensive weapons such drones are likely to be given to Pakistan sooner or later, and India must prepare an effective response. To address the military requirements for weaponised unmanned systems, the Indian establishment is reportedly pursuing indigenous capabilities to develop, manufacture, operate and support platforms and technologies related to drone weaponisation. The responsibility for such systems is between the ADE for developing weaponised MALE drones and Aeronautical Development Agency (ADA), responsible for the development of Unmanned Strike Air Vehicles (USAV), as part of its mandate.

The most important such Indian development is the Aura USAV, the most ambitious unmanned aerial system being developed by ADA. The Aura is being designed as a blended wing body, having low-observable (stealth) capabilities. The drone will weigh about 15 tons and will be powered by a single turbofan engine (likely the Kaveri, originally developed for the Tejas Light Combat Aircraft). This powerplant will be able to accelerate the drone to supersonic speed (Mach 1.2) at an altitude of 30,000 ft. It will be able to carry standoff precision strike weapons in two internal weapons bay, thus maintaining low radar cross section throughout the mission. Low-observability will also enable the Aura to carry out stand-in ISR and strike missions, enabling the air force to operate in contested access or denied enemy airspace.

However, the Indian armed forces would have the capability to operate combat UAS much before the Aura becomes operational, since some of the drones it already has can potentially carry external stores. For example, foreign media sources have been claiming for several years that Israel's UAVs (Heron I, Heron TP, Hermes 450 and Hermes 900) are capable of carrying guided weapons, just as their US counterparts (Predator, Reaper) can. Israel has never commented on these claims, referring to all air strikes performed by its air force as done by 'aerial vehicles'. IAI is currently offering the Super Heron to India, which drone is powered by an engine operating on heavy fuel, thus more suitable for operations from forward fields. The Super Heron has a payload of 450 kg, enabling the use of multiple internal and external payloads and stores. India is operating scores of Heron Is and, according to sources, also the larger Heron TP that can carry up to one ton of payload.

The Rustom II is another platform designed for 'offensive ISR'. The twin-engined drone will be powered by heavy fuel engines, with about $350 million committed for the initial production of 10 such drones. Rustom II will be able to cruise at an altitude of 30,000 ft. for 24 hours, carrying multiple payloads and weapons at a total weight of 350 kg. Rustom II has been planned to complete development by 2017 but delays in flight testing could postpone the in-service date.

Other systems already operational with the Indian defence forces are the Harop and Harpy lethal drones, delivered by Israel's IAI. These loitering weapons are designed for a single mission, which is to be 'suicide drones'. The UAV platform carrying the warhead is equipped with datalink and sensor payload and is programmed for autonomous operation with 'man-in- the- loop' control, enabling them to be used as loitering weapons for search and destroy missions. Employment of such drones is reserved for high intensity conflict, to neutralise enemy air defenses and missile threats. The use of limited numbers of loitering weapons such as the Harop are particularly cost effective in performing 'offensive ISR' against high value targets, on land or at sea, where rapid reaction is top priority.

The Harpy is fitted with RF sensors designed to detect radars and communications emitters, enabling suppression of enemy air defense (SEAD) and can be operated in synch with other SEAD means, supporting offensive strikes deep within enemy territory. Harop is fitted with gimbaled, electro-optical sensor designed to function in ISR and target acquisition applications. Harop has a range of 1,000 km and loitering endurance of 6 hours. Both drones will terminate their mission, 'screaming down' on their target in a steep dive attack.

Tamir Eshel

Boeing Defence Ad 1

Beloved Aircraft - or a Lemon ?

An 'open source' assessment of the LCA's status

Official announcements on "progress" of the LCA cause more worry than cheer. The postponements are now routine. In December 2013 we were assured that we should have two series aircraft by March 2014. What we got was one aircraft in October. That works out to half of what was promised after a delay of three hundred percent. The delays we are used to; the worry is that after sixteen machines and 2700+ sorties, is the programme so unsettled that it is difficult to get reasonable dates?

And FOC by May 2015 ? Doubtful. At best we might have the end of factory testing and the formation of a Handling Flight. This will be followed by the raising of the first LCA squadron with realistic IOC. The real troubles will begin then. As the new machines are bedded down in squadron service they will require support. If the squadron was raised at AFS

The first series production Tejas LCA Mk.I (LA-5001) before first flight on 30 September 2014

Halwara or AFS Hashimara it would have been a strong endorsement of the LCA's serviceability. By locating it at Sulur, 200 kilometres from the coastline and not a pressing air defence priority but close to HAL/ADA at Bangalore gives a message that the current serviceability may be doubtful. The product needs support. If so, why not raise the first squadron at AFS Yelahanka? The tart comments that may follow would be unpalatable but we can live with that as the troubleshooting will be faster.

A simple comparison

Given the above, the average 'LCA Watcher' is better off relying on peasant common sense to evaluate status of the programme. This below is my assessment and is made from what is available reliable 'open source' information (parameters compared with all aircraft in 'clean' condition with full internal fuel). In the table, I have compared the LCA Mk1 with the competition. From the figures emerged, some obvious "what if" questions which lead to simple suggestions of course correction.

To the average reader the figures are self-explanatory so I will restrict myself to comments after giving the usual caution that such figures are comparisons for two fighters *in vacuo*. All kinds of factors play a role in the outcome of any engagement not the least being X vs X combat. My own reactions after studying the figures are these.

First the bad news

We have a fairly mediocre fighter somewhere between the Gnat F.1 and the MiG-21 on our hands. Hence the IAF's present reluctance with the Mk.1.

- Both the F-16 and the JF-17 will give the LCA Mk.1 a hard time. The F-16A will be particularly dangerous. Even against the JF-17 it would be a Mysteres vs Sabres kind of a situation. I do not have much faith in the "great equaliser" capabilities of BVRs as of now. BVRs are not the weapon for a little LCA. Hence the JF-17 will also be a very dangerous opponent no matter how much we snigger about that Sino-Pak aircraft.
- As a MiG-21bis replacement, the LCA is a failure because the general rule of thumb is a 15 % increase in performance and capability. The LCA Mk.1 does not measure up. However, the landing speed and the cockpit displays will be better than the early MiG-21s which will help reduce accidents but let us not fool ourselves of having developed a MiG-21 replacement, particularly as an interceptor.

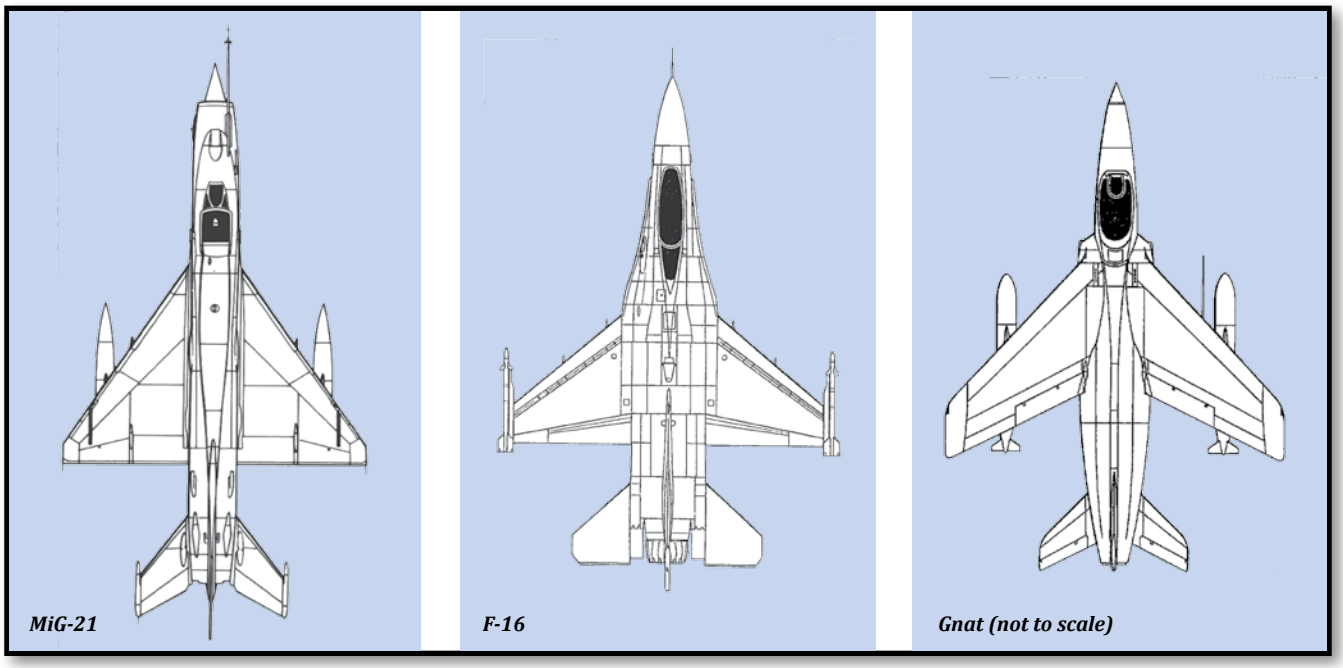
So what do we do?

And now the good news

The good news is that the LCA Mk.1 is a good replacement for the Hunters, Gnats and Mysteres of yore and to a certain extent the Sukhoi Su-7 that we had in '71. We had around 23 squadrons of these and the LCA could well be a candidate for ground attack tasks which, to me, was always at the core of the Air Force's business.

How do we go about that?

- As things are going, come 2020 the IAF will be forced to use the Su-30MKI or the Hawk for close air support. Neither bears thinking, to my mind. However, the LCA particularly given its small size will be better in this role.
- The IAF is allergic to using transonic aircraft, after having lost Hunters to MiG-19s and Mirages IIIs at Talhar and the gallant Sqn. Ldr. Mistri's loss is still remembered. However these losses were also because of zeal which should on occasion have been restrained.
- The IAF has to be persuaded to accept the LCA with minimal improvements, confined to improving critical platform performance parameters. The LCA for close support with Su-35 as top cover could be source of envy and a model to follow for many countries.
- To obtain that performance improvement, weight of the LCA has to be reduced to the original target of 5500 kg. If necessary, some equipment has to be deleted. The first to go will be the flight refueling. FR is an extremely expensive force multiplier and I cannot imagine using FR resources on a 'puny' warplane such as the LCA. If the IAF



MiG-21 *F-16* *Gnat (not to scale)*

is adamant, keep only a small number of LCAs with this facility. I remember developing and producing a Soviet (very 'Heath Robinson' but effective) Arctic heating system for the T-72 (it thawed out the lubricant, fuel and the engine and used the remaining heat to warm the fighting compartment) for the Army. They equipped only one third of their fleet and we lost a lot of business! There is no hard data on the efficacy of BVR. The BVR issue has to be debated constructively with TACDE help.

Weight improvement is the key

If we accept the above, then the question is how much are we going to get by 'weight improvement'? In the table, the LCA (5400) is an indication of how the LCA would stack up if we reduced the basic empty weight to 5400 kilos. We see that the LCA (5400) immediately becomes a reasonably competitive aeroplane against the competition. The question is "can we have an LCA at a basic empty weight of 5400 kilos ?"

What should be the weight of LCA Mk.1 ?

The starting point of this estimate is airframe of the HF-24. It was 2618 kilos including the cockpit canopy but excluding the undercarriage. My estimate is that the LCA airframe is about 10% smaller and should weigh (in all aluminum) about 2400 kilos. If we now factor in weight savings thanks to use of 65% composites, the LCA airframe should be 20% lighter. If not, then why are we using a strategically vulnerable material like composites since we don't produce the stuff ?

So the airframe of the LCA should weigh no more than about 1900 kilos, or about 2000 kilos as a rounded figure. Lets

Aspect Ratio (AR)	This will give a clue as to which way we should head.
Wing Loading (WL)	Clean full fuel weight divided by wing area. kg/m2\. gives instantaneous rate of turn.
Power loading (T/W)	Engine thrust in kg by above wt. multiply by 10 if you are a Newton fan. Where two figures are given it is full military and afterburner thrusts. The MiG-21 Bison's R.25 has two afterburner conditions, so two such T/W is given which indicates the aircraft's ability to fight in the vertical plane.
Induced Drag by Thrust (ID)/T	Ideally I should have Sustained Excess Power but have substituted it for ID by Thrust. This is the percentage of engine power used up by induced drag in a 3g turn at 350 knots and gives a fair indication of the aircraft's fighting abilities in the horizontal plane.

Type	AR	W/L	T/W	ID/T
LCA Mk. 1	1.8	242	0.52/0.84	0.35
MiG-21 Bis	2.2	354	0.64/0.87/1.14	0.39/.32
F-16 A	3.2	408	0.64/1.15	0.244
JF-17	3.7	372	0.48/0.95	0.23
LCA (5400)	1.8	212	0.6/0.98	0.28
LCA (5400/2.5)	2.5	208	0.6/0.98	0.20
Gnat F.1	3.6	237	0.71	0.20
Super Gnat (Adour)	3.6	286	0.95	0.24

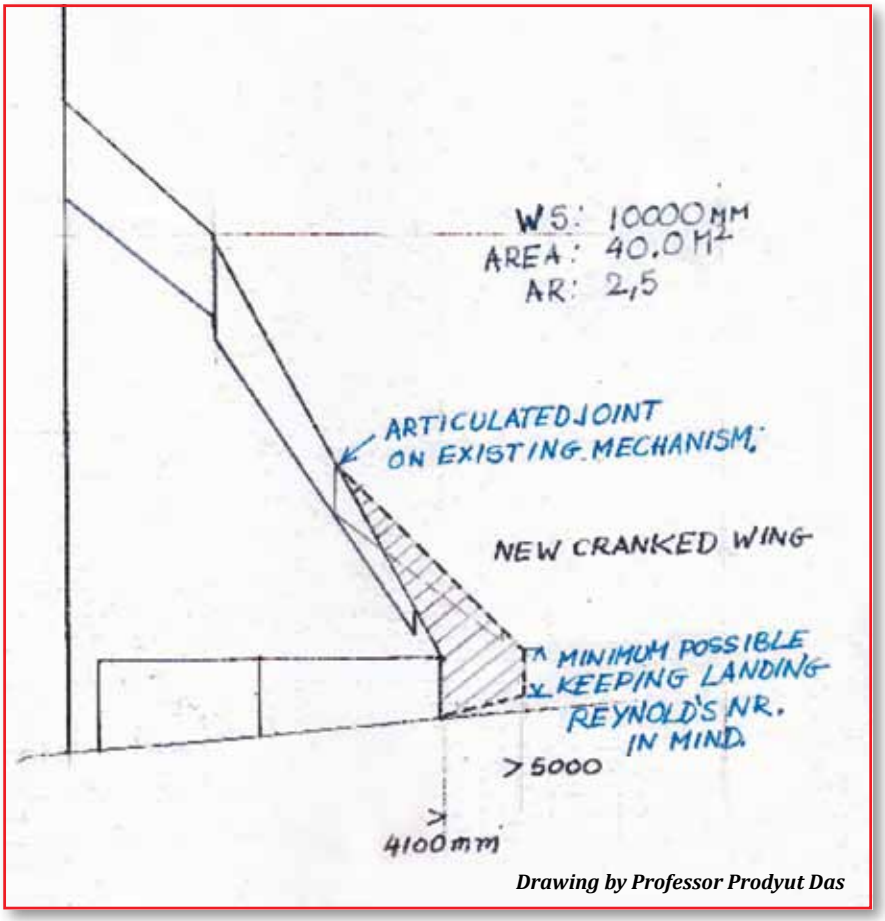
add up : we see that when added to the airframe weight we get a total 4100-4200 kilos. This gives a margin of 1.2-1.3 tons for all the remaining weights of brackets, cabling, piping, controls, shrouds and other items. ADA itself had maintained, for decades, that the basic empty weight of the LCA was around 5500 kg, only to spring a surprise before IOC that the thing was 1.3 *tons* overweight !

Fuselage lengthening

The requirement of minimum length of fuselage for a given cross section (CS) to get the desired C_d0 is well understood. I have always maintained that the LCA's fuselage was too short for its CS resulting in excessive drag. My guess is that at low level she will not do more than M 0.95 for all practical purposes. Most fighters of this genre have had fuselage lengths between 14 and 15 metres at least. I am putting below some figures which relate only to F404 engined fighters so the influence of the engine length on fuselage length is avoided.

- Gripen C 14.1 mts
- Lavi 14.39 mts
- F-20 14.2 mts
- LCA Mk1 13.2 mts

There are talks of increasing the fuselage length now. This point required pondering long ago, perhaps even as the first layout studies were coming off the printer.



Drawing by Professor Prodyut Das

Weight breakup	
Undercarriage	250 kilos
GSh 23 mm cannon	50 kilos
F404 engine	1000 kilos
Ejection seat	90 kilos
Accessories gear box	45 kilos
Multi mode radar	130 kilos
Other avionics	180 kilos (including FBW related)
Constant speed drive	40 kilos
ECS	30 kilos
Battery Main and Standby	50 kilos
Generators main and standby	60 kilos
Hydraulics and controls	260 kilos
Total	2185 kilos

Tweaking the Wing

The LCA suffers from having one of the lowest aspect ratios ever in any fighter resulting in high induced drag in combat. Instead of a major redesign of the wing, gives what would happen if the wing was 'tweaked' to have an AR of around 2.5 as with LCA (5400/2.5). The design conflicts for this would be to increase the span but with minimum increase in wing area to improve AR. I have increased the span by 1800 mms to 10 metres and the WA goes up to 40 sq. mts, which is a 3 sq mts increase. Keep the tip width as large as possible (but conflicts with minimum area increase above) in any case not less than 0.5 meters to keep the landing speed Reynolds number within steady flow. Otherwise she will rock/ wobble when coming in. Why overwork the FBW? Some tip camber may be required.

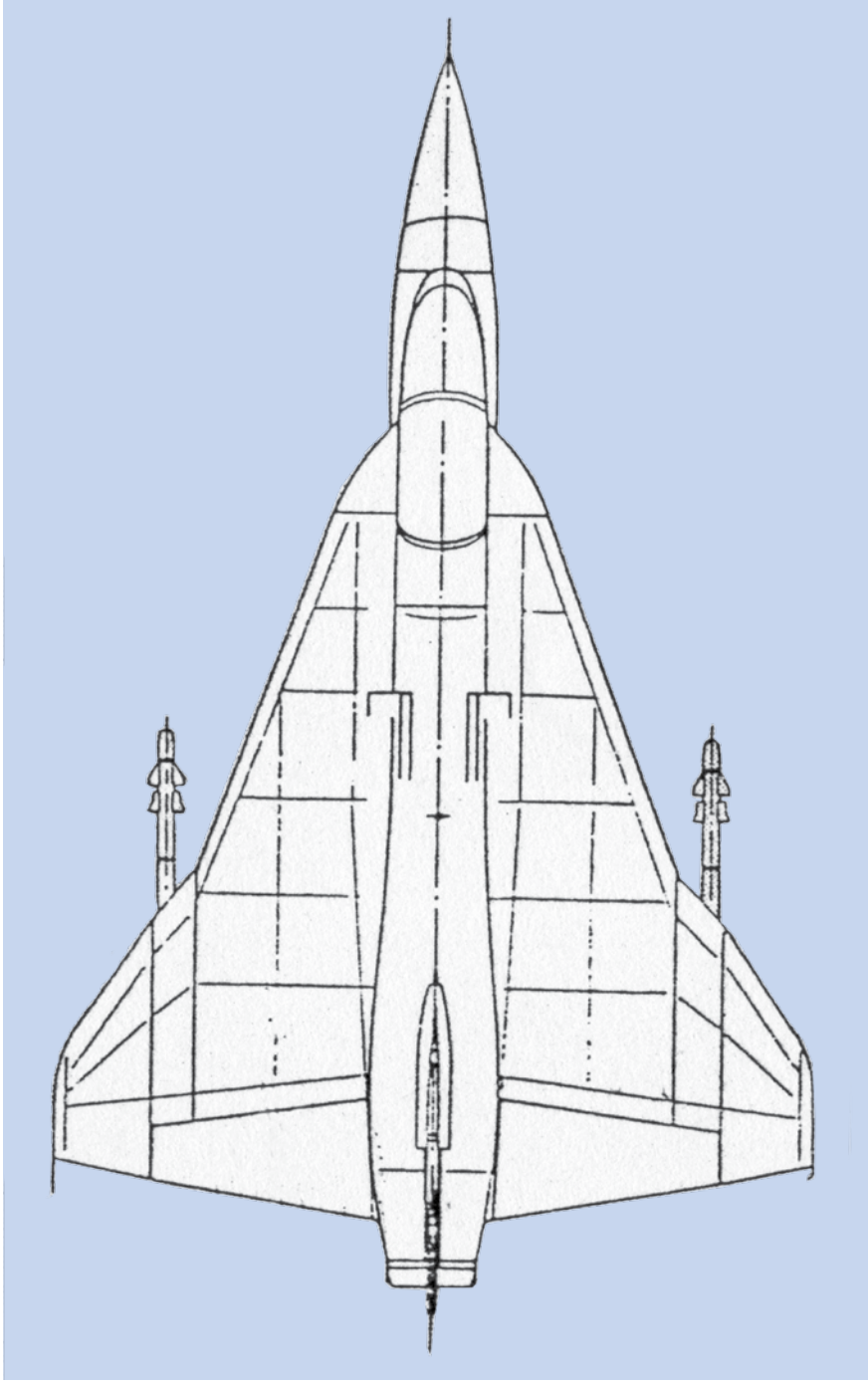
The logical solution is a trapezoidal extension. The hand sketch shows half the wing planform. The resultant 'kink' may need a fence/acorn to straighten flows there. Don't invent, use the MiG-21's fence to start with as the flow number will roughly be same. The Vmax and the rate of roll may go down by about 5% (visual estimate) but we would have a fighter which would stand up quite well to the F-16 in a 'real world' situation of 2 vs 2 or 4 vs 4. I had made a similar suggestion about tweaking the MiG-21's wing. The Chinese did something on those lines with their F-7P clone much later and reported excellent improvements. On the Gnat, Super Gnat and Hunters, I will write about at a later date but for the present, they show how much simpler and quicker it would have been for all of us to have based our design on the Gnat with just the smallest of improvements. This should have been seriously investigated then with the IAF supervising. It would be an excellent aircraft with plenty of potential for people building. It would have also been a short, low cost project which may have been the reason why it was ignored! It is still relevant with excellent export prospects.

What is to be done?

If we let things continue as they are, nothing will happen. ADA is an organisation which is risk averse. We have an excellent record so far (touch wood!) of no crashes but there is no prize for that. Saab, General Dynamics or Airbus are no fools and, in any case once the LCA gets an IOC (the actual one) we will have crashes, because nobody is better than a Flying Officer to find obscure design faults in an aircraft.

So here goes:

- This business of maintaining crash free record is to be closed. Crash free development, once you have enough prototypes, cannot continue to be a critical performance parameter. We have already beaten all world records for all time, so let's get real.
- There are two basic problems with the LCA : one is the weight and some aerodynamic refinement, the second is the slow production. Let's discuss the second problem first.
- Get a team which will ramp up the production, present faults and limitations *et al*. The Hunter Mk.1 was riddled with problems but Hawker's produced 160 of them, warts and all.
- For ramping up production, my suggestion, is to get the HJT-36 prototype management team back. They have performed !
- The team's task would first be to produce all forty LCAs ordered as fast as possible. The second is to have, by 2016, the plan to roll out LCAs at the rate of 60 per year and to have, by 2018, that capability in place. Even at that rate we will need ten years to complete the anticipated requirement.
- If resources cannot be found to produce more than the 14-16 per year then examine seriously whether we should have ambitions to be in this class of aircraft. During the days of "planned economy" the production rate of scooters was pegged at 100,000 p.a. well below an economic production rate, which encouraged a thriving black market.
- There can be no "wait until the design is proved". This is either a delaying tactic or lack of confidence masquerading as wisdom. You either believe in the certification process or do not issue a certificate. You can't have a certificate and then go slow. The idea is to protect airspace not the certificate. By going too slow we are killing the LCA project by creating a *force majeure* condition where imports may be the only recourse.
- Shying away from hidden faults is a wrong philosophy. Problems have to be hunted out and exposed by intelligently planned flight tests.
- The problems are persisting not because of 'high technology' but because of ADA's style of management. How else can one explain that the overweight problem was sat on since 1996? Why was the fuselage extension not handled



The initial design of the LCA, as proposed by the German firm MBB in 1984 had a compound delta layout, which would have met or even exceeded the performance requirements. Alas, this approach was dropped and the straight delta plan form adopted in 1987!

Check it out !

- Like the Kaveri, the LCA requires not more development but refinement. Lack of leadership in design both overall and detail has been a conspicuous and visible weakness.
- The product, in terms of the letter of the law, has failed to replace the MiG-21.
- LCA can however be a good clear weather strike aircraft which is what every AF needs in large numbers.
- To achieve the above, structural weight needs to be brought down. If still wanting, review some of the 'occasional use' equipment in the specs. And throw them out!
- We must snap out of the small annual production mind set. This will result in replay of the HF-24.
- In the absence of having anything better, get that HJT-36 development team back. Yes, they made mistakes but they made them fast and would have corrected them fast.
- This team should work on: improving the production rate to 60 per year and to build all 40 aircraft ordered (warts and all) by 2017. No more pussy-footing about further improvements because improvements are endless.
- Stop thinking about the LCA F414. The pure delta, with or without FBW, is a dead end in fighter design. Better think of using the basic fuselage with a conventional shoulder wing and tail, a la Gnat. Conventional wings are more 'tweakable' and in any case all the other 'stuffing' will largely be the same. All this, only after skills have been demonstrated by getting the LCA Mk1 right.
- Focus on the post-natal period of LCA's IOC. The HF-24 was often AOG'ed because of a lack of split pins! I am not being skittish when I say raise the first squadron at Yelahanka,
- Just as GTRE has to be reorganised, so does ADA if it is to be effective. Aircraft design is not all 'science". It still is an art. We always had the 'science' part but in setting up ADA the 'art' part was clearly neglected.

somewhere around 2005 when the flight trials must have shown up the excessive drag ? Weight and drag improvement is not high technology.

- Limit work on the LCA to basic experimental development. Do not form a committee to just tweak the wing; study ferry tips of the Harrier and do a fix using perhaps wood or, if you must, a foam and e-glass strap-on to verify the idea.

The LCA F414 – stop it !

There have been noises about getting the "right" aeroplane in form of the F414-powered LCA Mk.II. This rings alarm bells of all kinds. A new engine, new ducts, weight increases, new or re-written FBW(?), a new rear fuselage. We are hatching another wild goose to chase. The Swedes have increased the Gripen's fuselage length to 15.2 mts and the internal fuel capacity (by a 1000 kg more than the LCAs) in the similarly powered Gripen NG. The LCA's proposed 0.5 metres increase in fuselage length will surely reduce the Cd_o but it will not allow fuel capacity increase of more than 250 litres at best. We will be fuel short with the F414. In any case, the pure delta, with or without FBW, is a dead end in fighter wing plan forms. There is only so much you can do with it. Putting a more powerful engine to overcome sins of past, and present inadequate design supervision will result in a weight spiral to give us a 'barn door' and that too after uncontrolled delay. The LCA F414 will be a great help to those who are looking for a big, fat well-funded project with no timelines and no accountability.

I think if we just focus on the weight reduction, we will get a useful enough warplane. After that only minor tweaks, may be the wing tweak, should be done. We could, after the first hundred LCAs, talk in terms of a dedicated ground attack fighter with a MiG-27 style nose, 30 mm Gast gun (I think the Russians have one) and some armour up to STANAG 2 level to reduce vulnerability to *low cost* AAA defenses (LMG, MMG etc.). Warfare finally boils down to economics and losing a warplane to an F-16 is perhaps acceptable but losing it to a 19th century *jezzail* rankles !

ISRO and ADA : a case study

When INCOSPAR (later ISRO) was set up, the 'Essential Critical Technologies' for interplanetary flight were well known. The guiding lights of the ISRO programme,

Impression of the Advance Medium Combat Aircraft (AMCA) issued by the Aeronautical Development Agency

with humility of the truly wise, ignored critical technologies and set about with humble programmes for people building : range safety procedures, launch procedures, simple instrumentations small programmes where failures trained the people to take carefully calculated risks. The first ISRO rocket went up to 42,000 feet and was launched from what looked like a footstool and some ironmongery. The mentors of the programme did not shy away from risks and failures and kept a low profile. There was never any desire to "show" anyone anything. After thirty years (by the early nineties), ISRO had exceeded its original mandate handsomely. The recent *Mangalyan* has shown not only the skills but also any uniquely independent Indian approach, priorities and philosophy to spaceflight. ISRO is a world leader in low cost space flight and a triumph of Indian abilities.

The bureaucracy that created the ADA had the mandate to create another ISRO. They well could have. What they did was to create not a thought leader but a paradox – a dependant rival – made worse by a monopoly. This was repeated with the GTRE. It is not surprising that the Tejas programme is just where the Kaveri was - almost there but, like the frog in Xeno's paradox, it will never get there. Indignation is one thing but is there anyone on the programme who can give a credible date by which the aircraft will be 'fully ops' ?

Study the real causes of delay

Much is made of the effect of sanctions and funding in delaying the project but were these only causes for unacceptable delays? There must be an investigation on the effects of indecision and perhaps unprofessional decisions where the progress of the project suffered. How much time was wasted in removing leaders who dared to think independently?

The premature roll out of TD-1 is alleged to have set back the project by twenty months as reportedly the whole thing had to be re done. How much time was spent between the prototype being ready and the decision to fly the first sortie? These three alone may have contributed six years in direct delays. How much time is spent in ensuring "safety" to ensure a "crash free" development programme? Should resources have been allocated, for example, to the development of a turbo starter when there was allegedly a resources crunch that was holding up the main project?

The India-wide network of supporting institutions for the LCA programme certainly created a vote bank that would support the project to the hilt, its reviews and the requests for funds. We should examine what was the cost and effectiveness of the concept in terms of time required to review and supervise projects at distant stations? What was the mechanics of the remarkably indulgent project reviews at the highest levels that made a mockery of accountability? These are significant questions because unless these are analysed and lessons absorbed any future programme such as the fifth generation and the AMCA will go the same way.

Everyone loves a good drought

Public spending is always attractive for those who get to spend the money. It would appear that somewhere in the warrens of policy making there are people who want the LCA as a big fat project; they want it to continue indefinitely so they do not want it to succeed. The fact that we have the LCA flying is proof that at the engineering level there is no shortage of necessary skills. The problems of the LCA are simple and correctable. They must have been all known within the early months of flight testing. A reasonable sized group of young engineers suitably mentored could have solved them long ago.

The question that must haunt the Defence Minister today is : why were the problems allowed to fester for decades ?!

Professor Prodyut Das

Thunder from the North-West *

The Sino-Pakistani JF-17 has been in operational service since 2010, with the first production batch complete and development of an upgraded variant underway

As its initials are intended to convey, the JF-17 is a 'Joint-Fighter' whose evolution has been dictated by both pragmatic industrial compulsions as also strategic considerations. The fighter was essentially developed to meet the Pakistan Air Force's requirement for a modern (and affordable) multi-role combat aircraft to replace the obsolescent types in PAF service including the Chengdu F-7 and Dassault Mirage III/5 which types have constituted bulk of that Service's combat fleet since the past several decades. The aircraft was also intended to have export potential as a cost-effective and competitive alternative to the expensive Western-origin fighters flown by scores of Air Forces in Asia, Africa and Latin America.

In 1995, Pakistan and China signed a memorandum of understanding (MoU) to develop a new generation fighter and over the next few years, dedicated teams worked on the project. Interestingly, it was in June 1995 that the famed Russian aircraft design bureau (RAC-MiG) reportedly provided "design support" which also involved the secondment of several engineers to China. In 1999, the Chengdu Aircraft Industry Company (CATIC) came into a formal agreement with the Pakistan Air Force (PAF) for joint development and production of the JF-17.

This joint Sino-Pakistani single-engined fighter was developed, conceptually, as a 'modern MiG-21'. Given how global fighter fleets have declined since end of the Cold War, the objective seemed sound: a low-cost fighter which did not present major technical challenges and that could serve as an affordable option for revitalising many air forces. Like many such low-end projects, however, the "good enough" JF-17 has yet to catch on with certain Air Forces which remain fixated on prestige and technology.

Prototype of the JF-17 was rolled out on 3 September 2003, and test-flights were thereafter made by both Chinese and Pakistani pilots. JF-17s were initially being manufactured in Chengdu, Sichuan (42%) and Kamra in Pakistan (58%). The Pakistan Air Force shortly named the JF-17 as 'Thunder', while the Chinese designation 'FC-1 Xiaolong' means 'Fighter China-1 Fierce Dragon'. The JF-17 is sought to become the backbone of the Pakistan Air Force (PAF), complementing the General Dynamics F-16 Fighting Falcon and the indefinitely delayed order for the Chengdu J-10.

A second prototype flew on 9 April 2004 and was followed by another four (including one for static load testing) before eight small batch production (SBP) aircraft were completed for continuing development and clearing various stores and systems. The SBP aircraft joined the Test & Evaluation Flight at Kamra in 2008 which successfully achieved initial operational clearance (IOC), optimising the JF-17 for squadron service.

The JF-17 is powered by the Russian-origin RD93 turbofan engine (further developed from the RD33) which gives it a (smokeless) max speed of Mach 1.6. An agreement with Russia was initially signed in August 2007 for further procurement of 150 RD93s to power the JF-17s and the PAF is reportedly very satisfied with this powerplant. The aircraft has multi-role attributes and is employed for air defence, tactical reconnaissance and ground attack, carrying a variety of weaponry, including air-to-air and air-to-surface missiles, apart from its 23 mm GSh23-2 twin-barrel cannon with 180 rounds. JF-17s have reportedly been 'blooded' in the ongoing operations against militants in North Waziristan.

The JF-17 has a modern avionics package comprising a weapons and management computer, GPS and INS navigation, wide-band radios and a comprehensive self-protection package including chaff and flare dispensers and a missile approach warning system, besides a KG-300G self-protection jammer. The glass cockpit is compatible with night-vision equipment.

A JF-17 Thunder squadron took part in air exercises with the PLAAF in 2014

It has the Nanjing KLJ-7(V)2 radar, also co-developed and co-produced by PAC. This X-band fire-control radar uses a mechanically steered slotted-array antenna with multiple modes, making it suitable for the air-to-air, air-to-sea and air-to-ground roles. The radar can reportedly scan over 40 targets, track up to 10 of them in track-while-scan mode and simultaneously fire two BVR missiles. This radar, together with SD-10A active BVR air-to-air missile gives the PAF BVR capability and adds to the aircraft's air combat prowess. The PAF hopes to upgrade the system to an AESA radar.

The air-to-ground and air-to-air weapons include the PL-5EII advanced short-range air-to-air missile and high-and-low drag Mk92, Mk83 and Mk84 bombs. The JF-17 can carry a laser designator and targeting pod, allowing the use of LT-2 and LT-3 laser-guided bombs as well as the LS-6 satellite-aided inertially guided bomb. The C-802A radar guided anti-ship missile gives the aircraft an air-to-sea capability, but modifications are underway to enable the JF-17 to carry the CM-400AKG supersonic anti-ship and stand-off land attack missile. In Pakistan the weapon is referred to as the 'carrier killer'. In standard configuration, the aircraft is fitted with two SD-10As, two PL-5EIIs and two or three external fuel tanks.

The Pakistan Air Force has inducted some 49 units of the JF-17 (one was lost in a crash) from Block I, while another 50 of Block II are on order. The first PAF squadron (No. 26) was stood up in February 2010, and indicating the rapidity with which the Service 'operationalised' the type, two JF-17s were flown to the UK in July that year for display at the Farnborough Air Show. As further indication of the JF-17's 'maturity' in frontline service, a full squadron of JF-17s took part in a major exercise in western China in 2014, which marked the type's first large-scale out-of-theatre deployment.

The Block Approach

On 18 December 2013, the PAF's Chief of Air Staff took delivery of the 50th JF-17, completing the first two orders (including the SBP) and marking receipt of the final Block I aircraft. Prime Minister Nawaz Sharif was there to inspect the JF-17 and then inaugurate both production of the JF-17 Block II and the second batch of 50 aircraft for the PAF. The block approach allows a number of aircraft to be built in conformity with a fixed set of specifications. Although minor changes and upgrades are tested and sometimes introduced while a certain block is still under production, major alterations are generally introduced as a standard specification with the start of production of a new block or batch of aircraft. Production of the JF-17 is planned to be undertaken in blocks of 50 airframes, each successive block being an upgraded version of the preceding one.

JF-17 Block II has improved avionics, strengthened wing roots to carry additional stores, further optimised maintenance provisions and improved operational capabilities. A major addition is the air-to-air refuelling probe, a concept first tested on Block I aircraft.

The well reputed aviation analyst and writer, Air Commodore (retd.) Kaiser Tufail has said that upgrades may not require the aircraft to be sent back to the Pakistan Aeronautical Complex at Kamra, but could well be carried out at unit level. However, "as flight trials with different weapons are underway, it is time for hardware and software upgrades. I am not sure if these would be done at unit level or factory level; perhaps the former." Though the upgrades are not a radical departure from the Block I standard, Tufail nevertheless has "no doubt that they would improve the operational readiness considerably" for the Pakistan Air Force. What the future holds for the fighter is uncertain as details of a Block III variant have not been revealed, and Tufail says at present "no one seems willing to talk about them."

Similarly, analyst Usman Shabbir of the think tank *Pakistan Military Consortium*

Pakistan Prime Minister Nawaz Sharif being handed over model of the JF-17 by Air Chief Marshal Tahir Rafique Butt, PAF CAS in December 2013

has said that only reasonable speculation can made at present. "The JF-17 Block-III is at the concept stage presently but most likely will have AESA radar, HMD [helmet-mounted display] and some other avionics improvements. I am not sure if the airframe will be further modified for RCS [radar cross-section] reduction or airframe life enhancements. We just have to wait and see," he observed.

The Export Imperative

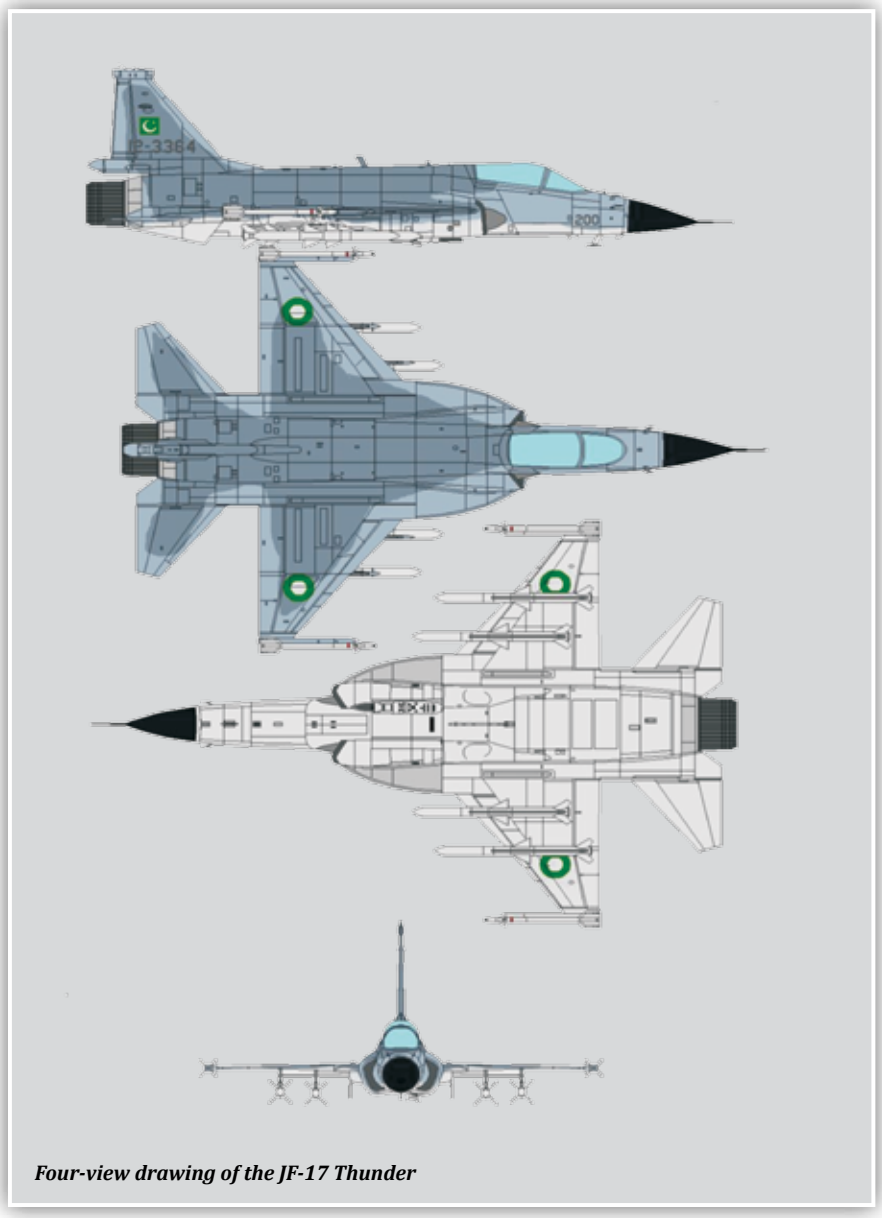
In order to reduce the aircraft's per-unit cost (reported at between US $20-25 million), the Sino-Pak 'consortium' has been vigorously marketing the JF-17 to various potential operators and although a number of countries have expressed interest, firm orders have yet to materialise. Usman Shabbir has pointed out that various problems face the fighter's most likely customers, but he is still optimistic. "Many of the countries that are probable JF-17 buyers have recently faced political or financial turmoil but it is highly likely that an order will be won within 2015."

"We are in advanced negotiations with an unidentified Middle Eastern country (*ed: likely to be Egypt)*, but the political situation over there has delayed the deal," stated Air Cdre Mahmood Khalid, Deputy Chief Project Director of the JF-17 programme, in an interview during the Zhuhai Air Show in 2014. "But we still expect them to be our first foreign client." There also are "advanced talks" in progress with other potential Air Forces in Africa, Asia, the Middle East and South America, but there is no official confirmation.

Over the past few years, China has been in negotiations with the Democratic Republic of Congo, Nigeria, the Philippines, Sri Lanka, Sudan and Venezuela, while Pakistan was concentrating on Turkey and Egypt, even as Indonesian Defence Minister Purnomo Yusgiantoro has confirmed that Pakistan had offered his country the JF-17.

"We've been receiving inquiries and expressions of interest on the JF-17 Thunder from many countries in the Middle East, Africa and even as far as South America," Air Marshal Sohail Gul Khan, the chairman of the Pakistan Aeronautical Complex, said at the Zhuhai Show.

Amongst countries which might have serious interest in the JF-17 is Argentina, which urgently needs to upgrade its fighter fleet as does Venezuela. However, the trans-national nature of modern aerospace industry (and especially of the European sector) attracts sanctions in many cases which leaves such countries with limited options. They can turn to Russia or China,



Four-view drawing of the JF-17 Thunder

and the Argentinean government appears to be talking to both. Argentina's interest in the JF-17 includes license-production of the type in-country.

Nigeria has reportedly also expressed some interest in the JF-17, to supplant its earlier Chinese fighters such as the F-7. The Nigerian Air Force has operated the Chengdu J-7 (MiG-21 clone) and there are reports that Nigeria could purchase as many as 40 JF-17s.

The JF-17 is affordable, and given the source material, buyers might have some hope that it will prove a reliable airframe. Russia has positioned itself to be a bit upmarket for countries like Nigeria, and perhaps even Argentina. If Nigeria and Argentina sign on, then similarly positioned countries such as Venezuela, Egypt, and others might also pursue procurements for the JF-17.

Beyond the JF-17: PAF interest in the J -31?

Also at the Zhuhai air show, Pakistan's apparent interest in the next-generation J-31 stealth fighter caused some stir, although Air Cdre Tufail feels that such an aircraft is not required by the PAF. "It seems to be a knee-jerk statement without much substance at this point in time," he said. "While stealth capability is welcome, the long-range requirement that goes with this aircraft may be overkill for an Air Force that is configured primarily for tactical air support to surface forces," he said. "Besides, a concerted strategic bombing campaign to decimate the enemy's war-fighting capability needs

The J-31 at Zhuhai Air Show, 2014

months to achieve results. That option is a non-starter for nuclear-armed belligerents, as much as it is for rest of the world, which can't sit back and watch the dangerous escalation," he added.

"So, I stick to my previously professed contention that it is tactical fighters that we need first and foremost. Two dozen or so stealth fighters seem more of a 'fashion' statement." He also highlighted a perennial concern for Pakistan that may rule out the J-31; "Who has got the money? Not Pakistan!"

Whether a Pakistani order for the J-31 will materialise is unclear, although there will be an eventual need to replace the F-16, which is the PAF's most potent front-line multi-role combat aircraft. Analyst, author and former Australian defence attaché to Pakistan, Brian Cloughley, has said the J-31 is a likely candidate, but "perhaps not for some time." He added that "it's being described in some quarters as an export machine, but that is bound to take a long, long time. Certainly there will have to be some sort of replacement for the F-16s, and it won't be European or Russian, for obvious reasons, so it must be China," he added, "I think we can bet on the J-31!"

JF-17s in PAF order of battle

The first PAF squadron to re-equip with the JF-17 Thunder was No. 26 ('Black Spiders') which received the initial batch in 2010. No. 26 Squadron's antecedents go back to August 1967, when it was raised at Masroor, Karachi as an operational training unit with F-86 Sabres. Over the next year, the unit converted over 400 PAF pilots and some 150 pilots from 'friendly' Air Forces. During the December 1971 conflict, No. 26 Squadron flew over 300 sorties from Peshawar in the air defence, counter-air and close air support role, carrying out most PAF air attacks against IAF bases in the Kashmir Valley, both Srinagar and Avantipur.

In December 1980, No. 26 Squadron was re-equipped with the Chinese-origin F-6 (MiG-19) but just four years later, converted to the A-5 III in the tactical attack role, continuing with the type at Peshawar till, in 2007, it was selected to receive the JF-17 Thunder. This was at Kamra (also site of the Pakistan Aeronautical Complex), before No. 26 moved to Peshawar some years on.

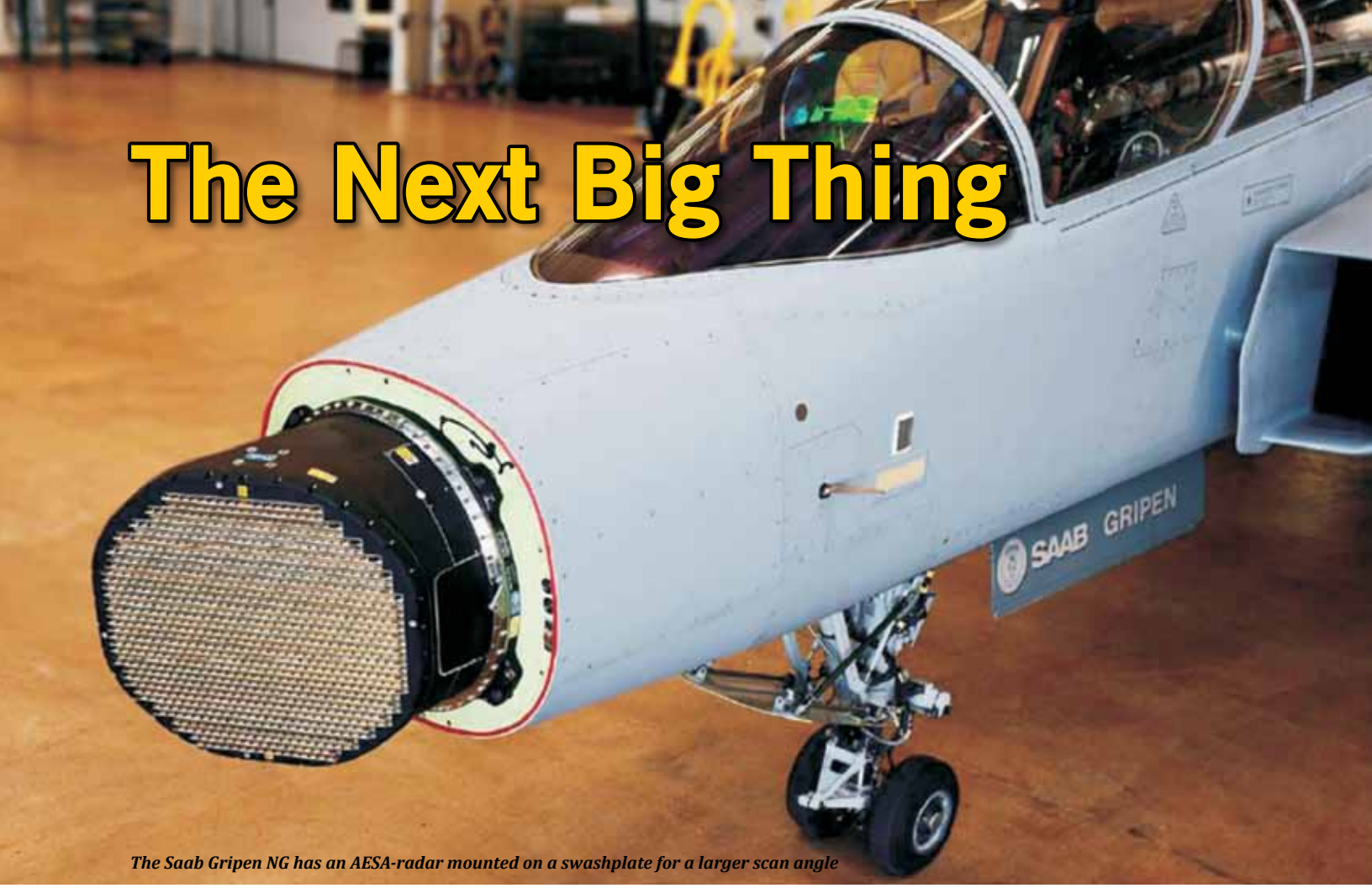
The second PAF Squadron with the JF-17 (PAC having built 50 aircraft under Block I) was No. 16 ('Black Panthers') which was originally a F-86 squadron, having been raised in 1957, 'number plated' in 1963, re-raised in April 1970 at Masroor and designated as a 'Fighter Leaders' School'

After the 1971 conflict, No.16 Squadron was disbanded and re-formed at Shorkot Road with the Chinese F-6 but, in February 1983, received the A-5 III to become an OCU for other PAF squadrons converting to the type.

In March 2011, No. 16 was moved to Kamra to re-equip with the JF-17 Thunder, becoming the 'Test and Evaluation' unit for the expanding JF-17 fleet. Co-sharing the base at Peshawar, No. 16 Squadron's Thunders have taken part in several international air shows including Dubai in 2013 and Zhuhai in 2014.

Clearly, both Nos. 16 and 26 Squadrons are 'heavy' in terms of aircraft numbers and the raising of a third JF-17 Squadron has been articulated for some time. To a direct question as to when this would happen, Air Chief Marshal Tahir Rafique Butt, CAS PAF, stated that this awaited "operational readiness" of a new air base. The next squadron of JF-17s will include Block II aircraft now under production at PAC Kamra, even as an increasing number of PAF squadrons with the JF-17 will surely become part of the PAF order of battle in the coming years.

The Next Big Thing



The Saab Gripen NG has an AESA-radar mounted on a swashplate for a larger scan angle

Opportunities of Gallium Nitride

Radar, if one simplifies it down to the basics, is a strikingly simple technology: radio waves go out, hit something and bounce back. With a little analysis of the return signal, you can "see" whatever is out there.

The radar 'buzzword' over the last few years has been AESA – Active Electronically Scanned Array. To understand the importance of the AESA it is perhaps pertinent to explore the capabilities and limitations of mechanically steered antennas, and the first generation – that is passive – Electronically Steered Arrays (ESAs), before getting into the details of modern AESAs and the types of semiconductors used in their production.

Radar basics

The radar antenna on an aircraft transmits electromagnetic waves in a beam and receives reflected waves from targets, or terrain, or anything in the way of that beam. To locate targets, it points this beam

The Tikhomirov BRLS-8B 'Zaslon' was the first PESA to be installed in an aircraft (the MiG-31 interceptor)

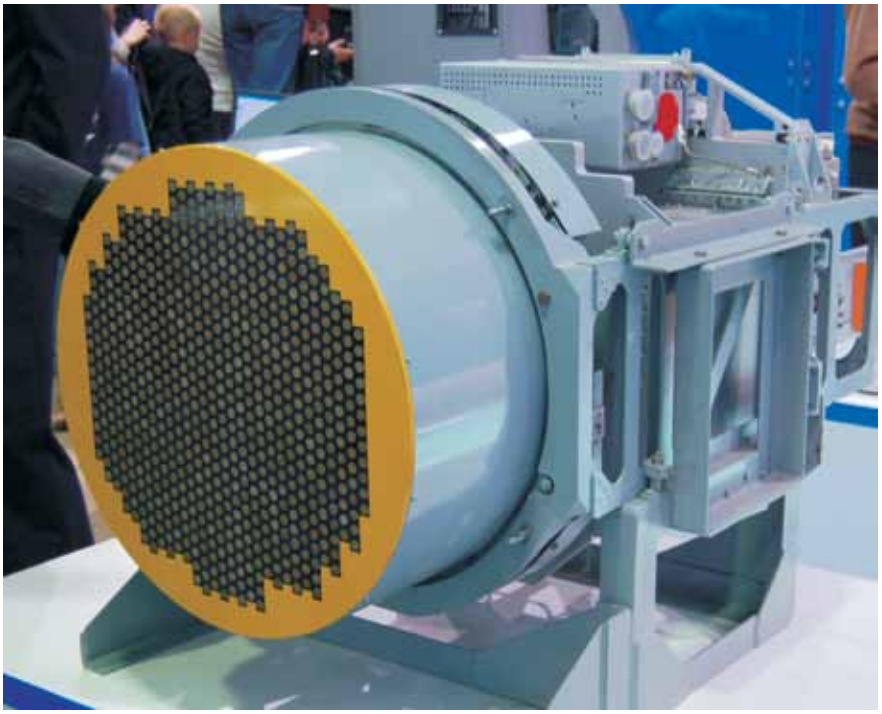
all over the sky or ground or both. So a good radar antenna is not only defined by its emitting power and receiving sensitivity, but also by how quickly and precisely it can be steered.

Early fighter radar antennas were mechanically steered concave dish antennas, which then evolved into planar arrays but still with mechanical steering. These are what most 1970s and 1980s fighters like the F-16 and F-18 were equipped with when they entered service. The planar arrays led to significant gains in radar beam quality but because mechanical steering was retained, they were still slow and of course had reliability issues as all moving parts do.

Around this time, computing was rapidly coming into its own. It was finally becoming practical to adapt the electronically steered antenna technology that was already in use on ground-based radars to airborne applications. These early electronically steered antennas had individual electronically controlled modules in an array, which would manipulate the time delay, or in electromagnetic wave terms, the 'phase,' of the microwave signal passing through each element. This is where the term 'phased array' comes from. By adjusting the phase at each module, the beam direction is manipulated without any mechanical intervention. Given that the phase changes were all computer controlled and electronically commanded, the earlier issues with speed and precision of beam steering were solved.

It's important to note here that the source of the radar waves, the microwave emitter, usually a traveling wave tube, was still a separate element of the radar installation. The 'active' element remained off antenna, which is why such radars are usually referred to as 'passive' electronically steered arrays (PESAs).

PESAs were a major step forward in technology and the beam agility alone made radars far more versatile, which, with the growing importance of 'multirole' aircraft obviously had positive implications for the future. However, the new design introduced a few new headaches as well. The phase shifters caused signal losses during transmit and receive, so microwave generators had to become that much more powerful. The mix of analog and digital technology undid many reliability gains from eliminating mechanical steering, and so on.



A Phazotron Zhuk-A on display at MAKS 2009 with TR modules visible on the array

The next development step brings us to the present day : instead of keeping various major radar components separate, the rapid pace of semiconductor technology development meant that all the disparate elements of a radar could, by the late 1980s, all be integrated together.

The phased array concept remained, but instead of phase shifters arrayed across an antenna, each spot on the array was made a miniature microwave transmitter and receiver. With the 'active' element of the radar now taking centre stage, the name is self-explanatory.

An AESA unit is crammed with Transmit/Receive Modules (TR Modules), each one an independent package comprising a low noise receiver, power amplifier, and digitally controlled phase and gain elements. Along with the obvious packaging and reliability improvements, the AESA approach yields improvements by virtue of design, which is why it's worth investing into the future potential of this technology. For instance, having the TR module's low noise receiver within the antenna itself results in a massive reduction in receiver thermal noise and by extension sensitivity. In practice, this improves detection range.

The cluster of individual modules do not need enormous amounts of power compared to early passive arrays, and can be driven by low voltage power supplies, increasing reliability of each element as well as the system as a whole. Improved power management also directly impacts the LPI – low probability of intercept – or 'stealthy' characteristics of the radar.

MMICs and Gallium Arsenide

The technology that really enabled this revolution was the Microwave Monolithic Integrated Circuit (MMIC), which is a microwave circuit on a single chip. And the material behind viable AESA MMICs is a semiconductor compound called Gallium Arsenide (GaAs). GaAs is a III-V semiconductor, which means one element in the compound – Gallium – comes from Group III of the periodic tabe and the other – Arsenic – comes from Group V. This is important, because *III-V* semiconductors have some very specific characteristics.

Compared to more common semiconductors such as silicon, for example, GaAs has around six times higher electron mobility than silicon, which allows faster operation of a transistor. It has a wider band gap, which allows sustained operation at higher temperatures, or results lower thermal noise in low power applications at room temperature. As a material therefore, it is ideally suited to the power and sensitivity requirements of radar.

On the other hand, however, silicon is cheap and easy to process, while GaAs

Mechanically-steered antenna on a F/A-18C Hornet undergoing maintenance

is brittle, expensive, and tends to be more difficult to work with. It took quite some time for the technology to mature - close to two decades - but development has been helped along by commercial demand and today reliable, high quality GaAs MMICs for AESAs can be produced at costs that are not unreasonable.

Gallium Nitride for the future

GaAs was just the first step on the AESA road. It may be a key enabler but it also has limitations.

As air combat shifts further into the BVR sphere, transmit powers will have to go up to maintain the 'first shot' advantage. The present generation of GaAs MMICs do not perform well at extremely high temperatures. Cooling electronics in an aircraft is always a difficulty because there is a lot of equipment competing for limited thermal cooling capacity available on board. Additionally, by nature of the semiconductor itself, GaAs does not operate effectively beyond a certain voltage, which limits heat management options from the power supply side as well. Conventional wisdom dictates that an increase in voltage should result in a commensurate reduction in current for a given power level, resulting in lower heat generation (since heat produced in electronics is directly proportional to current drawn) but because GaAs MMICs are already operating toward the upper limits of their voltage range, there is no way to take advantage of low-current power supply.

This is where Gallium Nitride (GaN) comes in. It is a relatively new development in the semiconductor industry, and while GaAs was already in limited production as far back as the 1980s, the first serious work with GaN only began about a decade later. However, it is a highly promising material for AESA MMICs as evidenced by the significant investment into its development, particularly in Europe and the USA. Where GaAs opened the gateway to the AESA world, GaN will pave the way for development that will really unlock the benefits of active arrays.

Like GaAs, it is a III-V semiconductor but with a few key differences that make it incredibly attractive for future improvement of AESA technology.

First, it operates stably and reliably at much higher temperatures than comparable GaAs chips. Second, it handles high supply voltages-around five times as high as GaAs-without any issues. This makes GaN an ideal material for a power amplifier because overall, it outperforms GaAs by a factor of five in RF power per unit chip size. The higher voltage supply has additional benefits: it simplifies onboard power conditioning, lightens cabling and reduces on board interference, not to mention helps with cooling. *(As noted previously, voltage goes up, current and heat come down.)*

In fact, GaN power efficiency is so high, it appears that further development of this will see chips limited not by electrical constraints but once again by available cooling.

The time is now!

Militaries around the world know why AESA is the "next big thing." Well, GaN is something that is going to make it bigger and better and it has not yet gained critical mass. It is not limited only to military applications either-as a semiconductor GaN will be incredibly useful for almost any microwave application. GaAs technology, incidentally, came about in no small part thanks to DARPA funding for radar development. Yet today the military market is one of the smallest consumers of GaAs MMICs, with telecommunications and other markets being key growth drivers. However, military applications have benefited tremendously from the economies of scale that followed in the wake of commercial adoption of this technology. There is no reason that GaN will not have similarly broad levels of acceptance across the board.

Today, the groundwork for GaN to take over from GaAs has been laid but GaN is nowhere close to the maturity of GaAs, in either the commercial or military sectors. Like GaAs in the past, it will take time for various non-military electronics sectors to decide whether or not investing in GaN is worth the effort and expense and then for production to ramp up to provide reasonable economies of scale. This is a window of opportunity for countries that are behind the technology curve to leapfrog to the front, at least in this specific field. The window, however, is not very large, and it will require a significant amount of human resources and funding to take advantage of this emerging trend. Any mis-steps or significant delays could see the opportunity wasted, and given how rare it is to have such a chance to close the gap to the traditional 'leading edge' nations, this would be tragic indeed.

Angad Singh

Adapted from a talk given by the author as part of a session on 'Emergent Technologies: Opportunities, Costs, Implications' at the Observer Research Foundation, New Delhi

New generation air-to-air missiles (AAMs)

Lockheed Martin F-35A conducting a separation test with an AIM-120 AMRAAM, while an AIM-9 Sidewinder remains on the wing rail

The air-to-air missile has come a long way since days of the Fairey Fireflash and the AIM-4 Falcon. Today's missiles are sleek weapons, radar guided and capable of engaging targets up to 100 km away at over three times the speed of sound. In this concise review, *Vayu* surveys the new generation air-to-air missiles developed by American, European and Israeli firms.

United States of America

Raytheon's AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) is among the most widely used air-to-air munitions by US and NATO forces extant. This has multi-shot, all-weather, beyond visual range (BVR) capability which, along with its low smoke solid fuelled rocket motor, make the AMRAAM one of the most potent air-to-air weapons in the world today. Variants of the AIM-120 are in operations with 36 nations across the world, with the missile capable of being carried by the F-15, F-16, F/A-18, F-22, F-35 JSF, Eurofighter Typhoon, Saab Gripen and the Sea Harrier amongst others.

Apart from the AMRAAM, American forces also rely on the AIM-9X Sidewinder to

French Navy Rafale M firing a MICA-RF

Rafael

Eurofighter Typhoon firing an AIM-132 ASRAAM

Saab JAS 39 Gripen with Meteor BVRAAMs and IRIS-T CCMs

fulfil their within visual range requirement. Developed in the late 1990s as part of a joint US Navy and USAF programme, the AIM-9X incorporates focal plane array sensors and a rocket motor on an agile thrust vector controlled airframe. The armed forces of eight nations have ordered the AIM-9X, with a more advanced Block-II variant currently under development.

Western Europe

There has been considerable activity in Europe on the development of cutting edge air-to-air missiles. At the forefront is the Meteor Beyond Visual Range Air-to-Air Missile (BVRAAM), developed by MBDA. Slated to enter service in early 2015, the Meteor is a Mach 4 capable missile with a range of 100 km. It is powered by a solid fuel variable flow ramjet engine, with the missile boasting a large no-escape zone and carries a blast-fragmentation warhead manufactured by TDW of Germany. The Meteor is to be integrated on the Gripen, Rafale and Typhoon with integration solutions for the F-35 Joint Strike Fighter available.

In addition to the Meteor, MBDA also produces the MICA (*Missile d'interception, de combat et d'autodéfense*) range of missiles for the Rafale and Mirage 2000 fleets in operation across the world. The MICA system comprises 2 versions: MICA (EM) RF with an active radio frequency seeker and MICA IR with a passive dual waveband imaging infrared seeker. MBDA intends the MICA to be deployed both as a BVR as well as WVR weapon systems. In the BVR mode, MICA offers multi target capability at extended ranges with interoperable guidance systems to hamper enemy countermeasures, while its agility and maneuverability makes it relevant in short range combat scenarios.

While the Meteor and MICA are MBDA's Beyond Visual Range options, the company has been marketing the Advanced Short Range Air-to-Air Missile (ASRAAM), known as AIM-132 in the USA, for within visual range combat operations. Equipped with the same focal plane array seeker as on the AIM-9X Sidewinder, the ASRAAM is kitted out with 3-axis fibre optic gyro inertial sensor and a low signature rocket motor. Of note is the fact that the ASRAAM has been selected as the standard close-combat missile (CCM) for IAF Jaguars, to be mounted on the aircraft's unique overwing pylons (*see article in this Issue*).

MBDA

Rafael Python mounted on an Israeli F-15D

Infrared seeker on a Rafael Python missile

MBDA isn't the only company producing air-to-air missiles in Europe. Germany's Diehl BGT produces the IRIS-T (Infra-Red Imaging System – Tail/Thrust Vector Controlled). In production since 2005, the IRIS-T is a short range guided air-to-air missile with high resistance to electronic counter measures. Development efforts started in 1990, when the Germans pulled out of development of the ASRAAM. The Mach 3 capable missile has a range of around 25 km, and counts the Eurofighter Typhoon, Gripen, F/A-18, F-16 and the Tornado as launch platforms.

Israel

At the forefront of Israeli efforts to produce advanced air-to-air munitions is Rafael Advanced Defence Systems. Starting with the *Shafrir-1* in the late 1950s, its latest system is the *Python 5*, considered as amongst the most advanced air-to-air missiles in the world. A beyond-visual-range missile, the *Python 5* retains the aerodynamic airframe and the inertial navigation system (INS), rocket motor, warhead and proximity fuse of its predecessor, the Python 4, while integrating a fifth-generation imaging seeker, modern software, advanced infrared counter-countermeasures (IRCCM) and flight control systems. It employs a dual waveband focal plane array (FPA) and the FPA ensures the attainment of small, low signature aim-points during day or night in clear and cloudy conditions. The highly advanced image and signal algorithms guide the missile towards the target.

Python-5 is also equipped with lock-on-before launch (LOBL) and lock-on-after launch (LOAL) capabilities. In LOAL mode, the target information is transmitted from the launch aircraft to the missile.

In addition to the Python 5, Rafael also produces the Derby beyond-visual–range active radar seeker missile. With a range of 50 km and capable of Mach 4 flight, the Derby missile incorporates look-down/shoot-down capability, sophisticated fire and forget mode and an advanced ECCM tailored to the customer's operational requirements. Derby's low weight allows it to be adapted to various modern fighter aircraft, including light aircraft, such as F-5, Mirage and F-16 while the Indian Navy's upgraded Sea Harriers are equipped with this missile as well.

Vijay Matheswaran

"The Perfect Marriage"

The perfect marriage : afterburning EJ200 turbofan engines on Eurofighter Typhoon makes for spectacular performance (photo by Geoffrey Lee)

Love and marriage, love and marriage, Go together like a horse and carriage
This I tell you brother, You can't have one without the other.

sang the legendry American singer Frank Sinatra but we can substitute horse and carriage for aeroplane and engine.

Eurojet's EJ200 proposed for India's AMCA

In any aircraft, the relationship between the air frame and its engine is a fundamental one. It defines the character, performance and ultimately the success of the design. That is why defining the thrust demands on the aircraft and subsequently the choice of engine will be one of the crucial decisions in India's Advanced Medium Combat Aircraft (AMCA) programme. The discussion around the thrust requirements for the AMCA is being followed with interest by a number of international aero-engine houses.

Vayu talks with Eurojet, the company behind the EJ200 engine, the power behind the Eurofighter Typhoon, for their take on the Indian market.

"There's no doubt about it, the engine is the key selection item for any aircraft," says Clemens Linden, managing director of Eurojet Turbo GmbH, who spearheads

Clemens Linden, Managing Director, Eurojet

the company. "If the air framer knows the engine from the start, they know how to design the aircraft.The success of the marriage between the EJ200 and Eurofighter came about largely because the respective teams worked together right from the very first start of the project. That's why there's such a smooth interface between aircraft and engine. In fact, the interface design between Typhoon and the EJ200 is so seamless that replacing an engine is a relatively straightforward operation. It's something that can be carried out within 45 minutes."

Clemens Linden continues, "The EJ200 has the advantage of being a mature

product, one that has performed well for more than 10 years now and in the six fleets of the Air Forces of the UK, Germany, Spain, Italy, Austria and Saudi Arabia, has clocked up over 500,000 engine-flying hours. Not only has it delivered a truly impressive performance, it has almost demonstrated unprecedented reliability. Depending on the requirements, we believe that the EJ200 will be the ideal engine for the AMCA because with such a reliable product to provide the power, the aircraft manufacturer would then be able to focus on the development of the aircraft itself, the avionics and the weapons integration system."

Developed over the timespan of a decade, Eurojet's EJ200 is known across the globe for its performance, capability and its competitive life-cycle costs. Since delivery of the first production engine in 2003, more than a thousand EJ200 engines have been supplied to the fleets of six nations, and the overwhelming feedback from the customer is that "it's the best in the world in its thrust class". He continues: "Whenever we talk to pilots in the air forces, they all say the engine is outstanding. They never raise any issues about it; they tend to say they just sit in and start it. It's easy to handle and it's carefree and highly reliable. That's the consistent feedback we get from the pilots who fly the Typhoon, which is a really great endorsement."

Based on the technology, the EJ200 can be considered a 4.5 generation engine. It is a low bypass ratio turbofan, and consists of an eight-stage compression system, with a single turbine each in the high-pressure and low-pressure turbine stages and thrust augmentation systems currently providing 90kN (20,000lbf) thrust in reheat for the Eurofighter Typhoon.The powerplant features high-end compressor technology and, including its reheat system, is about 4 metres long with a dry weight just of approximately 1,000 kg. It boasts a thrust to weight ratio of close to 1:10. The flight shut down rates are well below industry average and the mean time between engine removals is better than specification and reliability figures far better than plan.

According to Eurojet, "If you compare it to previous generations then we have a fantastic on-wing time – more than a thousand hours on average. In fact, the fleet leader in the RAF has achieved over 1,700 flying hours. These kind of performance figures are unprecedented in combat engines where on-wing hours can often be measured in the low hundreds.

EJ200 on test bed

Indeed performance of the engine was so impressive that Air Marshal Simon Bollom, Air Member for Material and Chief of Material, RAF, remarked on its performance in a recent mission: "We only took one spare engine, and were confident that would be enough," citing the design's "inherent reliability."

Can the EJ200 meet the additional thrust requirement of the AMCA? Eurojet's Sales VP Colin England says,"It is important to bear in mind that today's engine is the first batch of the production engines. We have never carried out an upgrade in any respect, because there has been no requirement so far. This leaves lots of room for future enhancements. We have a very solid base line right now and we've got great growth potential to further develop the engine,including customising it for a new application.In particular, one growth area that Eurojet has already developed is a thrust vectoring nozzle which provides numerous aircraft benefits, particularly in the areas of manoeuvrability, agility and fuel burn savings.

Inspecting an EJ200 at the Rolls Royce facilities

Mr England goes on to say that the through life costs of the engine are another area where the EJ200 scores highly. Rather than a conventional overhaul schedule the Eurojet's advanced maintenance methods allows the operation and the life of the engine components to be actively monitored through a sophisticated engine health monitoring system."The system measures actual rather than perceived usage and we calculate operators can get up to a 50 per cent saving in through life costs" says England."In essence there is no need to strip the engine down and no need to remove the engine for specific periods – the EJ200 is very good on that score. We know that in a competitive market we have to provide a cost effective solution and that's exactly what Eurojet stands for."

The design of the EJ200 is unique. It is made up of a total of 15 different modules and during maintenance and repair periods as many as seven modules can be exchanged without the need for the engine to undergo a bench test before being reinstalled in the aircraft.This capacity to make servicing such a simple, slick and speedy operation is a truly exceptional characteristic of the engine.

"This kind of thinking is what helps set us apart," adds England. "Of course the engine was originally designed for economic life-cycle costs and we can demonstrate that this is indeed the case with the experience we have gained up to now. That is certainly one area we are giving more and more focus to in order to further optimise the costs.

The other major strength of Eurojet is in the partnership opportunities it brings. Indeed the consortium behind Eurojet, Rolls-Royce (UK), MTU Aero Engines (Germany), ITP (Spain) and Avio Aero (Italy) is solid proof of successful partnership working.The consortium allows for open discussions of technical issues and incorporates the views of four chief engineers. This unique combination of different perspectives adds up to higher quality technical outcomes. Partnering is part of Eurojet's DNA.

Clemens Linden concludes: "Eurojet has advanced manufacturing techniques and technologies – many of which we are able to share. This can support national agendas such as 'Make in India' and it provides a great potential to advance both expertise and in-country capability. Recent developments, such as the higher share of foreign investments and opening up of the defence sector to private sector participation, create a number of localisation and partnership opportunities which are significant."

Facts about the EJ200 engine

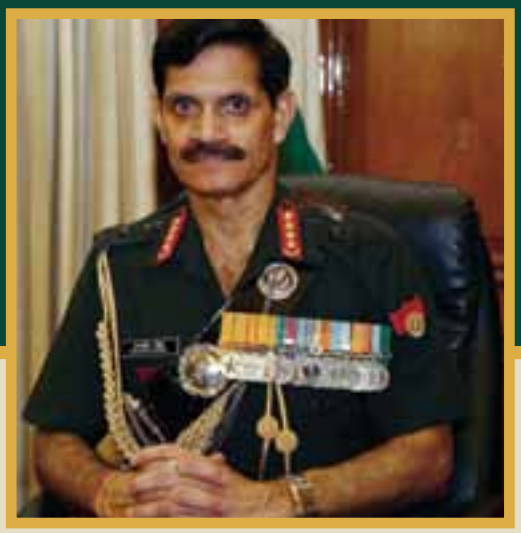
- The Eurofighter Typhoon powered by two EJ200 engines can cruise at supersonic speeds without afterburner.
- A single crystal turbine blade is designed to operate 200°C above its melting point. That's like stopping an ice cube from melting in an oven !
- At its heart, in the combustion chamber, the heat is nearly half the temperature of the surface of the sun - and the pressure is the same as half a kilometre down in the ocean.
- The force on the small first stage turbine blade at take-off is about 10 tonnes, which is equivalent to hanging a double-decker bus on each blade.

Vital Statistics

Type	Twin Spool Turbofan with afterburner
Launch application	Eurofighter Typhoon (two EJ200 engines)
Further applications	Single or twin engine fighter aircraft
Thrust	90 kN (20,000 lbf) with reheat 60 kN (13,500 lbf) without reheat
Bypass ratio	0.4:1
Pressure ratio	26:1
Specific fuel cons	47-49 g/kNs with reheat 21-23 g/kNs without reheat
Airflow	75 - 77 kg/s
Compressor stages	3LP, 5HP
Turbine stages	1HP, 1LP
Combustion system	Annular Airspray
Weight	ca. 1,000 kg
Length	ca. 4 m

Facing the Challenge : the Indian Army today

Interview with General Dalbir Singh, COAS



On completing six months as Chief of the Army Staff, please enumerate your vision and focus areas for the Indian Army.

COAS : Six months back itself I had enumerated my vision which was to ensure capability enhancement and development effectiveness to meet contemporary and emerging challenges, provide the guiding framework to remain our focus for the future. My key thrust areas will include achieving highest standards of development preparedness, force modernisation, make up critical deficiency of weapons and equipment and infrastructure development with special emphasis on our Northern and NE Borders. Human Resource development, improving organisational climate and welfare of veterans and *Veer Naris* are other areas of high priority.

The Indian Army maintains constant vigil along the Siachen Glacier, highest battleground in the world

What are the internal and external challenges before the Indian Army today and how well are we prepared to meet the emerging situation?

COAS : The Indian Army is mandated to safeguard national interests from external aggression and internal subversion. Our borders have become increasingly active over the years. These vast borders passing through some of the most rugged terrains in the world, with large areas being disputed, pose complex external security challenges. Our internal security challenges are intricately linked to our external threats. Terrorism and the involvement of non-state actors with state sponsorship has brought about a fundamental shift in the conduct of warfighting. These remain one of the biggest threats to an emerging India. The Indian Army is fully aware of the emerging security scenario and our capability enhancement efforts are focused towards preparing the Army to effectively meet the contemporary and future challenges.

Attack Helicopters have been vested with the Army now. What is the status of acquisitions of these helicopters? What has been planned with respect to training of pilots and maintenance aspects?

COAS : Wars of the future will be fought in an integrated combined arms environment. It will be critical for the field force commander to be able to concentrate resources and fire power at the critical point and time. Attack Helicopters provide the requisite punch in a short and intense battle with enhanced ability to the commanders

HAL Rudra light attack helicopters are being acquired by the Indian Army

Elbit 1st ad

Indian Army Commandos fast-roping from an Army Aviation Dhruv ALH

to 'look, move and strike deep'. Plans for training, support and infrastructure for operational and maintenance requirements are already underway.

Modern armies are getting digitised and automated and the Indian Army cannot lag behind for which a concerted drive is required. What are the Army's plans for digitisation and how much has been achieved till now?

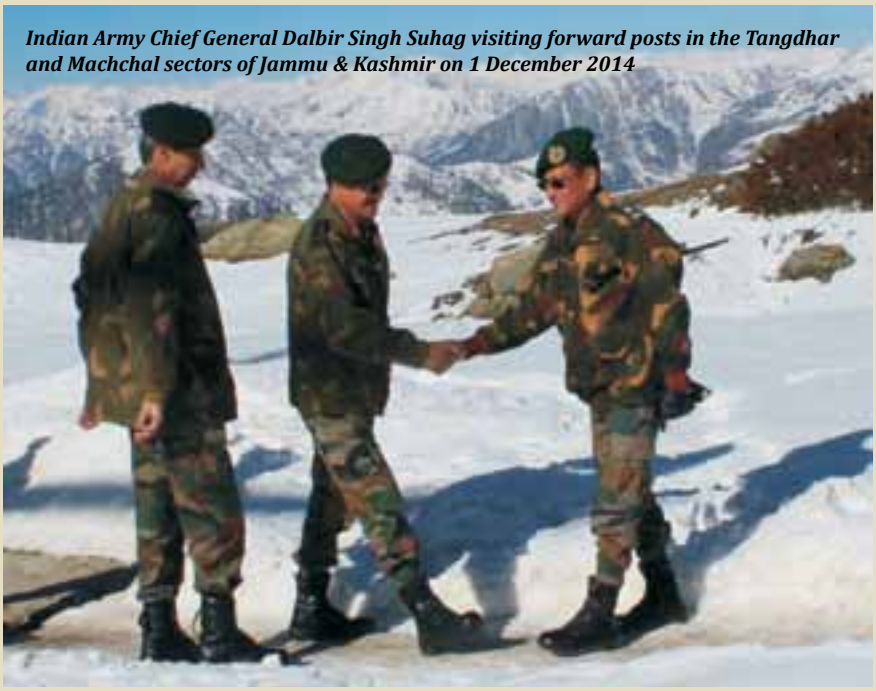
COAS : The Indian Army has defined a framework for the Digital Army Programme which is in concert with Government's *Digital India Programme*. Indian Army is already digitised in some of the areas which include career management, pay and allowances, equipment management and messaging systems.

Similar automation applications are being development for functions related to equipment procurement, storage, maintenance, logistic management and GIS. The connectivity for the above processes is provided by a secure Army Data Network, which is available to all units in the Indian Army. This would be further consolidated post implementation of NFS and ASCON Phase 4 projects by 2016. Mobile communications (MCCS) have been established in two Corps locations and is planned for other locations as well.

On the situation in Jammu & Kashmir and prognosis for the future?

COAS : The security situation in Jammu and Kashmir is at a crucial juncture. Relentless ops by the Army on the Line of Control and in the hinterland along with other Security Forces have thwarted the designs of the Pak–ISI–Separatists – Terrorists nexus in giving fillip to the proxy war being waged against India. There is a need to consolidate gains to further stabilise the security situation for which all enablers are a development imperative.

The Army has assiduously combated terrorism in the State through people-friendly operations and zero tolerance for HR violations. Indian Army has maintained moral ascendancy over the enemy's nexus both on the Line of Control and in the hinterland. The future will depend on the stability obtained in the neighbourhood, improvement in own capability and response mechanism as also the will of people of Jammu & Kashmir.



Indian Army Chief General Dalbir Singh Suhag visiting forward posts in the Tangdhar and Machchal sectors of Jammu & Kashmir on 1 December 2014

Army troops boarding Ilyushin Il-76 heavy transport aircraft of the IAF

Bel

The Indian Army has been engaging in a large number of joint exercises with 'friendly' foreign countries. Why do we engage in such exercises? What are the specific areas of cooperation and interoperability we are looking for ?

Gorkha soldier with Carl Gustav anti-tank weapon during joint exercise Yudh Abhyas 2014 with the US Army

COAS : Defence cooperation activities constitute an important tool for furtherance of our national interests. In keeping with India's rising global stature, recent years have seen considerable increase in defence cooperation activities undertaken by the Indian Army. Accordingly, an increasing number of Friendly Foreign Countries (FFCs) have been requesting to engage with the Indian Army, which is viewed as one of the most professional and disciplined forces, with exemplary training standards and vast development experience. The prevailing dynamics in the region are complex. Threats are being faced from multinational terrorist organisations and non-state actors. Indian Army's endeavour is of mutual benefaction in capability building and empowering armed forces to counter threats from terrorism. Concerted efforts are also being made to ensure coordination at the functional level to be able to provide timely humanitarian assistance and disaster relief in times of crisis. These activities are aligned to the national endeavour to establish India's credibility as a responsible nation of the region, committed to regional peace and stability.

How are the shortage of officers in the Indian Army being addressed ?

COAS : Shortage of officers presently exists in the support cadre at the level of Lieutenant Colonel and below. This has primarily impacted manning at unit level. The above has, in-turn, resulted in additional responsibilities being shouldered by officers. While high levels of development readiness and efficiency are being ensured with available officers, there is a need for heightened commissioning of Short Service Officers in order to make up the deficiency. We are proactively addressing the issue in conjunction with MoD. In this regard, a positive trend has been witnessed in the last few years as overall deficiency has been reduced from 26% in 2010 to 17% in 2014.

Indian troops are deployed at high altitude along the northern and western frontiers

Stress on personnel of the Armed Forces has to be expected : What stress management plans are there to address this problem?

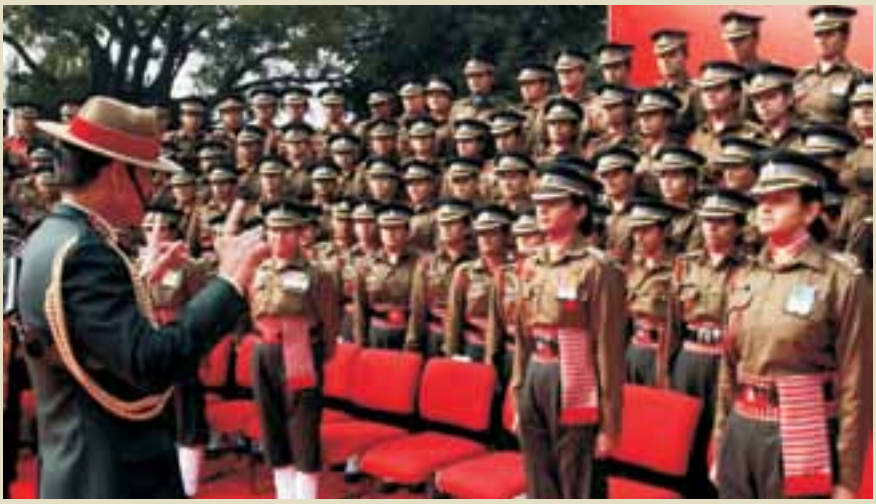
COAS : Stress and strain is a stark reality of life these days and the Army personnel are not immune from it. Several measures have been put in place to counter the same. These include sensitisation by commanders, addressing grievances through interactions, implementation of 'buddy' system, welfare measures like provision of married accommodation, schooling, recreation etc. Besides these basic measures, more specific actions like screening of personnel for any stress markers, specifically personnel at high risk of combat stress, psychological counselling, training of counsellors are also being undertaken.

The helpline *Mansik Sahayata* is being established at respective Command HQ under the aegis of Command HQs, and is already functional at the Northern and Southern Commands.

Recently a number of incidents have happened where officer-men relationships have been reported. What are your comments on these ?

COAS : I must tell you that the Indian Army still maintains one of the best officer-man relationships in the world. The Army has a well institutionalised structure as far as officer-man interaction and relationship is concerned. Prime importance is accorded to this aspect which can be borne from the fact that despite the Indian Army troops being subjected to the harshest of living conditions in inhospitable terrain in the border areas, the Indian soldier has never let the Nation down and has performed creditably against all odds. This indicates the high level of motivation which can only be inspired by a congenial and 'comrades-at-arms' atmosphere, as is prevalent in the Indian Army.

(Courtesy : Sainik Samachar, Directorate of Public Relations, Ministry of Defence)



COAS addressing women officers at the Army Day parade

Bharat Forge

The Army's 'Seven Critical Projects'

COAS inspecting the parade at Delhi Cantonment on 15 January 2015

Chief of the Army Staff General Dalbir Singh has identified 'seven critical projects' for modernisation of the Indian Army. These include acquisition of 814 howitzers (155mm) ; new generation anti-tank guided missiles ; various helicopters for the Army's aviation wing ; upgradation of main battle tanks ; acquisition of assault rifles ; bullet proof jacket ; new helmets for the infantry and night vision devices.

FH77B 155/39 howitzer at the parade

He was addressing the media on 13 January 2015, two days ahead of Army Day. The COAS also stated that the western borders are live and "the terrorist infrastructure across the border is intact. Pakistan Army's support to the proxy war in J& K continues unabated despite suffering casualties its own country". Pakistan still has 44 terror-training camps directed against India on its soil, the majority of them being in Pakistan-occupied Kashmir. "At least 17-18 of them are active 24x7".

The Army is, however, much more sanguine about China despite many seeing it as a bigger long-term threat. "The border with China is peaceful in tune with the policy of constructive engagement… the CBMs in place are very effective," Gen Suhag said. The problem of transgressions and face-offs will end if the Line of Actual Control with China is demarcated, he added.

T-90S main battle tank at the parade

(Photographs by Angad Singh on Army Day at Delhi Cantonment Parade Ground)

61st Cavalry on parade

MKU

Vayu Visits Airbus in Toulouse

Handing over ceremony of

Vayu was invited on short notice to Toulouse on 21-22 December 2014 to be on hand at handing over of the first Airbus A350XWB to Qatar Airways. The day and a half was packed with excitement to state the least !

As always, we were hosted by Stefan Schaffrath, VP Media Relations to a buffet dinner at the Radisson Blu Hotel, close to the airport. Next morning, after the 'check-in-to Qatar Airways A350 XWB media flight' at the Airbus Delivery Centre, there was the programme pesentation by Didier Evrard, EVP A350XWB followed by a product pesentation by Kiran Rao, EVP Strategy & Marketing. This was followed by speeches, a press conference with Q&As with HE Akbar Al Baker, Group CEO of Qatar Airways, Tony Wood, President Rolls Royce, Aerospace and Fabrice Brégier, President and CEO Airbus.

Then boarding began for the Qatar Airways A350 XWB media flight where along with Airbus executives, we had another opportunity for interaction. On landing, we departed for the very interesting A350XWB Final Assembly Line (FAL) tour.

So, what was this all about? Airbus was to deliver the first A350 XWB, the world's latest generation widebody airliner, to launch customer Qatar Airways, on 22 December 2014. The A350 XWB "redefines the way people will fly for the

First A350 XWB delivered to Qatar Airways (A7-ALA) took off for a media flight on 22 December 2014. Starting in early 2015, the first Qatar Airways A350 XWB will be operated daily from Doha to Frankfurt, Germany

A350XWB to Qatar Airways

coming decades and opens up a new era in comfortable, efficient long-haul air travel when it enters service with Qatar Airways, renowned for leading the industry to new heights in service excellence", stated Airbus officials.

The A350 XWB "embodies the most advanced technologies and breakthrough innovations in aerodynamics, light-weight materials and aircraft systems". Powered by Rolls-Royce Trent XWB engines and having an extra-wide, bright and spacious cabin, the A350 XWB promises to be a "firm favourite with travellers" who will discover a whole new way of flying. Airlines will also benefit from unequalled levels of operating efficiency and cost effectiveness.

Qatar Airways Group Chief Executive, Akbar Al Baker stated "Receiving the A350 XWB as global launch customer is a very proud moment for Qatar Airways, and after much anticipation, I am delighted that the day has come when we will welcome this latest generation aircraft into our rapidly expanding fleet. In the seven years since we first placed our order for this new aircraft type at the Paris Air Show, investing in a partnership programme with Airbus, there has been significant growth in the airline industry. I am confident that this increase in passenger numbers around the world will only increase further in the years to come, and I am delighted that Qatar Airways will

(continued on page 6)

Rolls-Royce joins Airbus and Qatar Airways in celebrating delivery of the first A350 XWB

Rolls-Royce joined Airbus and Qatar Airways in celebrating delivery of the first Airbus A350 XWB to enter service, and powered by Trent XWB engines. Akbar Al Baker, Qatar Airways, Fabrice Brégier of Airbus and Tony Wood of Rolls-Royce, were at the formal aircraft handover ceremony at Airbus headquarters in Toulouse, France.

Speaking during the A350's delivery press conference at Toulouse Blagnac Airport, Tony Wood, President - Aerospace for Rolls-Royce, called the jetliner's handover to Qatar Airways "a landmark event in the aerospace industry"

"The RR Trent XWB is the sole power plant available for the Airbus A350 XWB. More than 1,500 engines have already been sold to 40 customers and sales of the Trent XWB account for over half of the Rolls-Royce civil aerospace order book. The engine is expected to be in service for many years, creating an annuity of aftermarket services that will generate revenues for decades to come. The A350 XWB delivers a 25 per cent fuel burn improvement compared to previous generation aircraft," stated an executive.

The Trent XWB is also one of the quietest engines that Rolls-Royce has ever produced for the wide-body market, and is the result of years of research and development and advanced engineering of more than 20,000 parts. It has been tested to extremes of performance on the ground and in the air around the world. It is the sixth member of the Trent engine family which, along with the RB211, has built a reputation for excellence over four decades.

As John Rishton, Rolls-Royce, Chief Executive Officer, said: "We are very proud to have worked with Qatar Airways and Airbus to produce the A350 XWB, using the latest technology to deliver new standards in customer service. This is a very important day for everyone at Rolls-Royce. It is the culmination of years of hard work and the start of a new chapter for our business."

First... but not the last! Qatar Airways' 1st A350 accompanies its 4th A380 on delivery to Qatar

Departing Toulouse on its delivery flight to Qatar Airways' base in Doha, was the airline's first A350 XWB accompanied by its big sister A380, the fourth for Qatar Airways, which also made its first journey home. With the delivery of this A350, the airline becomes the first carrier in the world to operate every family of Airbus' airliner portfolio, comprising the A320, A330/A340, A350 and A380.

Celebrating the 200th Airbus aicraft assembled in Tianjin

A well attended ceremony was held at the Airbus (Tianjin) site to celebrate the 200th A320 Family aircraft assembled by the Airbus Tianjin Final Assembly Line (FAL). Daniel Baubil, Airbus Executive Vice President and Head of Single Aisle Family Programme handed over the A319, a member of the A320 Family, to China Eastern Airlines, which is one of the largest airlines in China and was the first Chinese airline to operate Airbus aircraft (A310) in 1985. China Eastern Airlines now operates a fleet of more than 270 Airbus aircraft. In March 2014, Airbus, TJFTZ and AVIC agreed to extend the successful Joint Venture for another 10 years, from 2016 to 2025. The extension, or 'Phase II', will include the final assembly of the A320neo Family from 2017 onwards for delivery of these single-aisle aircraft to the Asian region.

Kiran Rao, Airbus head of strategy, making a presentation at the first delivery of A350 XWB to launch customer Qatar Airways on 22 December 2014. "We knew what the competition was and that we needed to produce something superior," he stated

A350 XWB Programme head Didier Evrard (seen with Mr. Akbar Al Baker, Qatar Airways Group Chief Executive and Airbus Group CEO Tom Enders): "We did a great job, demonstrating what Airbus can do best!"

Guests were invited aboard the first-delivered A350 XWB for a demonstration flight from Toulouse-Blagnac Airport prior to the aircraft's departure to Qatar

be leading the way in the aviation sector in offering our passengers the opportunity to travel on board the most modern of airliners in the sky."

John Rishton, Rolls-Royce, Chief Executive Officer said: "We are very proud to have worked with Qatar Airways and Airbus on the A350 XWB, using the latest technology to deliver new standards in customer service. This is a very important day for everyone at Rolls-Royce. It is the culmination of years of hard work and the start of a new chapter for our business."

As Fabrice Brégier, Airbus President and CEO said, "Handing over the first A350 XWB represents a significant step in Airbus and aviation history. The A350 XWB becomes the most modern aircraft in service, developed with our excellence established over 45 years in meeting our customers' needs. The A350 XWB is the latest Airbus aircraft to join the skies, revolutionising our industry and redefining the way people fly." He added, "It is with tremendous pride that we are delivering our first A350 XWB today to our launch customer, Qatar Airways. It's a perfect match, to be handing over the first of an all-new, world class aircraft to a leading, world class airline."

"The A350 XWB fits seamlessly alongside Qatar Airways' growing fleet of A380s and A330s, making the carrier the world's first airline to operate each member of Airbus' market-leading Widebody Family. Qatar Airways' A350 XWBs, in combination with their A380s and A330s, will offer unprecedented levels of interoperability and comfort on the rapidly expanding Qatar Airways network of excellence", stated the Airbus spokesperson.

The A350 XWB is latest addition to the Airbus Widebody product line. Offering its customers a reduction in fuel-burn, the all-new mid-size long-range A350 XWB has carbon fibre fuselage and wings and sets new standards in terms of passenger comfort, operational efficiency and cost-effectiveness.

VSC

Airbus A350-900 receives FAA Type Certification

The A350-900 has received Type Certification on 12 November 2014 from the US Federal Aviation Administration (FAA). The A350-900's FAA and EASA certification awards came after Airbus successfully finished a stringent programme of certification trials which took the A350-900 airframe and systems "well beyond their design limits" to ensure all airworthiness criteria were fully met. The fleet of five test A350-900 aircraft completed the certification flight test campaign, on time, having accumulated more than 2,600 flight test hours.

75 years of Pilatus Aircraft

On 1 August 2014, which was the Swiss National Day, Pilatus Aircraft Ltd. officially unveiled its first PC-24 prototype at a world premiere at Buochs airfield in central Switzerland, witnessed by some 25,000 spectators (*photo above*). The show began with a unique team of 24 horses pulling the first prototype out of the production halls. The horses were chosen to symbolise the number appearing in the PC-24 product name and its future mission profile as a 'workhorse'.

The new jet has an elegant design in Swiss style, featuring chrome and gold-coloured Alpine flowers. The rollout was preceded by a fly-past of all the aircraft which have ever reached series production in the company's 75 year history. Over 120 performers and more than 160 children of company employees made the rollout an unforgettable event for high-ranking guests, customers and fans of Pilatus.

Oscar J Schwenk, Chairman of the Board of Directors of Pilatus, was enthusiastic about the new PC-24 and the event: "This celebration is a clear sign of our commitment to Switzerland as a centre of vision and action. Our company was established here in Stans exactly 75 years ago. We have seen our activities grow and expand here, and this is where we want to be in the future: in Stans, producing our aircraft for sale to customers around the world. It's wonderful that so many thousands of guests from Switzerland, and also from countries nearby and further afield, have made the effort to be with us here today, to celebrate this event together. The PC-24 marks a really important milestone in our 75-year history !"

An ebullient Amelia Rose Earhart after landing her PC-12

Federal Councillor Ueli Maurer who attended the event paid tribute to the success of Pilatus in his speech, remarking on the new Swiss business jet with great pride. He also announced that the members of the Federal Council have voted to buy a PC-24, a further sign of the confidence placed in the new Pilatus-produced jet.

The entirely newly-developed PC-24 is the first time that traditional Pilatus values such as versatility, efficiency and Swiss precision have been combined in a jet aircraft. The PC-24 is the world's first ever business jet to come equipped as standard with a cargo door, with the kind

of performance specification that allows it to operate in and out of very short runways or even unmade strips.

A total of three prototypes will be produced for the PC-24 test flight programme. The maiden flight of the first prototype, which was presented at the rollout, will be in spring 2015. Final certification and start of deliveries to customers are planned from 2017.

Pilatus has already sold 84 PC-24s at the European Business Aviation Conference & Exhibition (EBACE) in May this year.

Aound-the-world flight in a PC-12 NG

While not a direct relation to Amelia Mary Earhart of 1937 fame, Amelia Rose Earhart was inspired by her legendry namesake. Landing at Oakland International Airport, Amelia Rose Earhart had returned to her flight origin and so "closed the flight plan" of the original Amelia Mary Earhart. In doing so, Amelia Rose Earhart became the youngest woman to fly around the world in a single-engine aircraft, which drew attention to her foundation to fund flight scholarships for young women interested in pursuing a career in aviation.

Ms. Earhart has been a pilot since 2010 and worked as a professional newscaster in the Los Angeles and Denver metropolitan areas. This particular flight plan was first considered while she was still in high school. After more than a decade of dreaming and several years of actual planning, Amelia finally made the flight a reality.

Earhart, along with co-pilot Shane Jordan, selected the Pilatus PC-12 NG as the aircraft of choice for this arduous journey. Earhart stated, "The PC-12 NG was the perfect aircraft in which to complete this flight. Its renowned reliability and performance removed much of the inherent risk associated with a flight of this nature. And, its large cabin gave us plenty of room to stretch out and stay alert on the long flight legs. I am delighted to report that the aircraft performed flawlessly throughout our 16-day journey. Over the total 24,300 miles, we did not incur a single issue to interrupt our flight plan."

Earhart's flight plan endeavoured to stay as close as possible to the original 1937 Earhart flight as current geo-political conditions would allow. In order to accomplish the long over-water legs of Amelia's flight, the aircraft was fitted with a 200-gallon auxiliary fuel tank, which extended the PC-12 NG's standard range of 1,830 nm to over 2,500 nm with comfortable reserves.

While flying over Howland Island, the last known position of Amelia Mary Earhart's infamous flight, Amelia awarded 10 flight scholarships to young women across the United States through the '*Fly With Amelia*' Foundation.

The Pilatus PC-12

Elbit 2nd Ad

The Airbus Group : major presence at Aero India 2015

The C295

From commercial and military aircraft to helicopters and radars, the Airbus Group is presenting a wide range of cutting-edge products and technologies at Aero India 2015. The focus of Airbus Group's participation is to highlight its strong footprint in India and commitment to the Government's 'Make in India' campaign. "We have been used to partnerships in India as is shown by our long standing collaborations with several Indian public and private companies as well as R&D organisations and academic institutions. We are enthusiastic about the 'Make in India' campaign and are ready to leverage our existing local partnerships and invest in new ones to make the most of it. Aero India offers the perfect setting to discuss our plans to make in India with various stakeholders. We look forward to our participation in the show," said Yves Guillaume, President – India, Airbus Group.

On display at the Group's pavilion (OD8) in front of Hall C, are scale models of the A380 and the A320neo. Also on exhibition are scale models of the A330MRTT mid-air refueller which has been selected by the Indian Air Force and the C295 transport aircraft which has been offered to India, in partnership with Tata, for the Avro replacement programme. Two 'Made-in-India' products – High Accuracy Air Pressure Measurement System and Structurally Integrated Antenna – are also part of the display line up. Both these products have been developed at the Airbus Defence and Space engineering centre in Bengaluru.

A model of the EC725 which recently underwent Field Evaluation Trials (FETs) for the Indian Coast Guard's tender for 14 shore-based helicopters is on display too. The EC725, fitted with the relevant weaponry and sensor suites, well meets the Indian Navy's 120+ Naval Multirole Helicopter (NMRH)

programme requirements and the Indian Army's 150+ Tactical Transport Helicopter fleet expansion plan. In addition, there are models of the AS550 C3e Fennec and the AS565 MBe Panther. The Fennec is foreseen for the Indian Army's and Air Force's Reconnaissance & Surveillance Helicopter (RSH) campaign which was recently re-started under the 'Buy and Make (Indian)' category whereas the AS565 MBe Panther fits the requirements of India's Naval Utility Helicopter (NUH) programme which envisages acquisition of around 100 units.

On the civil helicopter side, scale models of the single-engine EC130 T2 are being showcased while those of TANAN unmanned aircraft system, SPEXER 2000 border / coastal surveillance radar, MILDS missile warning system and TRS-3D multi-mode surveillance and target acquisition radar are also being presented. In addition, information on the Group's border security solutions, Maritime Satellite Services and GEO Intelligence Imagery & Net management System is available at the stand.

On the last two days of Aero India 2015, the Group will organise a recruitment fair at its pavilion for experienced aviation engineers. Airbus is looking for engineers with post-graduation or more for open positions in Avionics, Structural Analysis and Repair Approvals. HR representatives from the company will be available at the fair to meet interested candidates, review their CVs and guide them on the selection process.

Yves Guillaume, President – India, Airbus Group

ASRAAM

To protect IAF Jaguars

MBDA's AIM-132 ASRAAM (Advanced Short Range Air-to-Air Missile) has been selected as the 'fire-and-forget' Close Combat Missile (CCM) for over-wing installation on Indian Air Force–operated Jaguar strike fighters. The ASRAAM will progressively replace the currently deployed MBDA R.550 Magic. As the Jaguar is a low-flying aircraft, the threat is projected to come from higher altitude, so two missiles will be carried on the Jaguar's over wing station. Over wing pylons call for quick missile separation and ASRAAM being the fastest, lowest drag CCM weapon on the market inherently provides safe separation, unmatched 'snap-up' capability, plus guaranteeing 'first shot first kill' to avoid getting involved in an unnecessary dogfight. Presently MBDA's ASRAAM is in service with the United Kingdom and Australian Air Forces "to provide an optimum solution" given its ability to provide short to medium range protection passively.

The 2.9metre-long, 88kg missile is heavily optimised for best possible pre-merge performance, following the contemporary dictum that "whoever gets the first shot off is likely to win." Therefore the missile is built from the outset to acquire an opponent and successfully engage it at maximum range. Still, should the first shot not succeed; the missile is designed to provide close-in performance to destroy the target aircraft at close quarters. The key to the missile's acquisition range performance and high off-boresight capability is the 128 x 128 element Focal Plane Array (FPA) Indium Antimonite seeker mounted on a two axis gimbal. The device is manufactured as a single Indium-Antimonite die, and is in effect a single chip low resolution thermal imager sensitive in the 0.5 to 5.4 micron band. FPA dramatically increases sensitivity, because it 'stares' continuously at the target thus exposing a much larger detector area for much longer to the target's emissions. Moreover, because it uses a television style scan, rather than conical reticule scan, it is for all practical purposes immune to flares as well as blinking Infra-Red (IR) jammers.

The only robust countermeasure is a laser with sufficient power to 'blind it' or burn it out. Because the FPA produces what is essentially a TV picture of the target scene, it is virtually impossible to break lock by violent manoeuvre at any range, also since the gimbal mechanism will adjust the line of sight of the FPA. The target airframe is tracked using contrast lock techniques similar in concept to those used by the AGM-65 Maverick ASM, and therefore escape from seeker coverage is geometrically impossible providing the airframe can keep up.

The ASRAAM warhead is of compact blast fragmentation design, fired by a Thorn-EMI laser proximity fuse, with a backup impact fuse. The highly accurate ASRAAM is in effect a 'hittile,' as the warhead serves the purpose of guaranteeing the otherwise almost certain kill produced by a direct hit with a high velocity missile airframe.

Sayan Majumdar

Brahmos

Barak-8 (LR-SAM) tested

On 10 November 2014, Israel Aerospace Industries (IAI), in collaboration with the Israeli Ministry of Defence, conducted a successful test of the Barak-8 air and missile defence system, which is referred to in India as the Long-Range Surface-to-Air Missile (LR-SAM).

The Barak-8 advanced air and missile defence system provides "ultimate protection" against a variety of aerial platforms, in both land and naval scenarios. For both point defence and long-range anti-missile and air-defence, if offers a unique high performance defensive capability owing to its modular design, and a secure net-centric architecture.

The LR-SAM system integrates several components from different suppliers, both Israeli and Indian. Rafael, which also manufactures the missiles for the Barak-1 system already in operation with the Indian Navy, is supplying the Barak-8 interceptor missile, which remains vertically launched. DRDO, which is the prime development agency for the programme, is providing the missile's dual-pulse rocket motor, as well as pneumatic actuators and arming/safing technology. The battle management, command, control, communication and intelligence centre system is produced by IAI MBT, while IAI's Elta Systems subsidiary supplies the EL/M-2248 Multi-Function Surveillance, Track and Guidance Radar (MF-STAR) S-band radar, which is already installed on the Navy's Kolkata-class destroyers. IAI is also the design authority for the overall system.

The Barak-8 provides protection against a variety of aerial platforms and munitions including aircraft, helicopters, unmanned aircraft and sea-skimming missiles. It is based on a sophisticated missile, state-of-the-art phased array multi mission radar, two-way data link, and flexible command and control system.

The system's radar, manufactured by Elta Systems, is a multi-mission unit, supporting air defence missions and is a digital Active Electronically Steered Array (AESA) incorporating the cutting- edge in radar technology. It delivers an accurate, high quality, real-time arena situation picture and extracts low Radar Cross Section (RCS) targets even in the toughest environmental conditions.

Barak-8 is designed to operate by day and night, in all weather conditions, to deal with simultaneous threat engagements, even in severe saturation scenarios. The system has very short reaction time and a fast missile vertical launch capability with 360-degree coverage. It optimises coordination between missiles by using an advanced broadband communication network. The missiles are capable of engaging short, medium, and long range threats, and interconnectivity among multiple ships in a naval task force enables the system to be a multi-layer air and missile defence system.

The recent test validated all components of the weapon system to the satisfaction of potential operators who were present. Israeli specialists and Indian scientists participated in the test, along with officers from the militaries of both countries. The test began with launch of the target. After being detected by the missile system's radar, the system calculated the optimal interception point, launched a Barak-8 missile in an optimum trajectory to acquire the target, and successfully intercepted it. All the system components met the testing goals successfully.

Joseph Weiss, President and CEO of IAI, was present at the testing-site and stated that "The system's impressive, advanced capabilities proven today in this complex test are another testimony of IAI's resilience and advanced groundbreaking capabilities. The Barak-8 Air & Missile Defence System is a major growth engine for the company."

Dr. Avinash Chander, then SA to RM was in attendance and declared "This is an important milestone in the cooperation between India and Israel on development of the Barak-8 advanced air defence system."

Boaz Levi, Executive Vice President and General Manager of Systems, Missiles & Space Group was similarly effusive, saying that he was "very satisfied with the test results" and that "success is an important example to the fruitful collaboration between the Israeli MOD, defence industries in Israel and customers in Israel and abroad."

Barak-8 missile is launched during the test

Hermes 900 UAS taking off

Elbit's range of Unmanned Aerial Systems

Elbit Systems is exhibiting its comprehensive range of unmanned aerial systems (UAS) at Aero India 2015, from the man portable Skylark I mini-UAS through various tactical drones, up to the latest Hermes 900 medium-altitude long endurance (MALE) UAS. Israel was a pioneer of military UAV operations, and Elbit's UAS products today reflect the decades of operational experience gathered in Israel and other countries around the world.

Elbit's UAS are not only mainstay of the Israel Defence Forces (IDF) unmanned fleet, but also equip militaries around the world. For instance, Elbit has designed and developed the British Watchkeeper Tactical UAS, with a design based on the Hermes 450, adapted to British requirements in collaboration with Thales UK. U-TacS, the UK-based Thales-Elbit JV, has established comprehensive UAS development, production, and support capabilities to produce the Watchkeeper UAS as well as other system elements.

With an established position in the UAS field, Elbit is now constantly exploring new challenges, and besides the UAVs themselves, now offers a range of payloads and sensors for various missions, ground control systems, ground support equipment and UAS trainers. The firm also provides UAS maintenance and training services, supporting users from delivery to fielding and throughout the life cycle of a system. In addition, Elbit's international experience makes it well placed to execute cooperation programmes with local industries, including transfer of technology (ToT), subject to government clearances.

The Hermes family of UAS for Medium Altitude Long Endurance (MALE) and high end, cost-effective tactical UAS, along with the Skylark family of UAS for close range tactical and organic, man portable UAS capabilities, provide a comprehensive range of multi-layer solutions for diverse operational needs from a single source of supply.

Multi-layer UAS platforms

Hermes 900 : equipped with multiple advanced payloads, this Medium Altitude Long Endurance (MALE) UAS developed from the successful Hermes 450 offers key additional capabilities such as longer endurance, increased flight altitude of (over 30,000 ft), and larger payload capacity (up to 350 kg). A 2.5 metre long internal payload bay that can accommodate payloads up to 250 kg allows rapid modular payload installation and replacement. Hermes 900 also uses an advanced satellite communication data link.

The Hermes 900 leverages its development heritage and employs the same ground control station, line of sight data link, sensors and key ground support equipment elements as the Hermes 450. This allows seamless insertion of Hermes 900 UAVS into forces already familiar with the Hermes 450, with logistics savings and minimal additional training. The Hermes 900 UAS has been selected by the Israeli Defence Forces (IDF), Chile and an "unnamed nation" in the Americas.

Hermes 450 : Presently the backbone of the IDF's UAS fleet, the Hermes 450 is a versatile long-endurance system, typically equipped with Elbit's DCoMPASS gimbaled electro-optical sensor. The Hermes 450 can also use a wide range of other payloads including Sythetic Aperture Radar/Ground Moving Target Indication (SAR/GMTI), medium power radar, ESM/ELINT, COMINT/DF, Large Area Scanning and hyper-spectral imaging. Certain dual payload configurations such as COMINT with electro-optical imaging are also deployable.

Hermes 450 is highly autonomous and is controlled by the Hermes Universal Ground Control Station (UGCS), which is capable of directing two concurrent missions when allocated two ground data terminals (GDTs). The communication LOS (line of sight) data link range extends up to 300 km, allowing for greater operational flexibility, and is capable of transmitting images and data in real time to ground stations during missions. Its autonomous ATOL (Auto Take-off and Landing) system enables auto-landing even on alternate non-instrumented runways in case of diversions.

The aircraft can fly at altitudes up to 18,000 feet, and a modified engine in the current variant allows it to operate from higher altitude fields and shorter runways with reduced engine-noise levels,

Hermes 450 seen in flight with an electro-optical surveillance payload

IDF soldier hand-launching a Skylark

facilitating quieter operation. Designed for minimal maintenance, the Hermes 450's cigar shaped fuselage provides high structural integrity and is cleared to fly many thousands of flight hours.

Hermes 90 : An expeditionary tactical UAS, the Hermes 90 is runway-independent, with the mobility of a smaller UAS, thereby providing manoeuvring forces with high end sensor capabilities normally restricted to larger drones. Hermes 90 has long endurance (up to 18 hours) with a mission range of up to 100 kilometers, and can deploy a variety of payloads. Multiple launch and recovery methods include a launcher for point launch and skids for recovery on non-prepared, short surfaces without needing any dedicated ground equipment. Wheeled take-off and landing from short runways is also an option if an airfield is available. The basic Hermes 90 configuration features a Micro CoMPASS day/night electro-optic payload, featuring exceptional surveillance performance. The aircraft can also be equipped with other payloads such as Large Area Scanning system or COMINT/DF as required, all of which is controlled from an advanced ground control station that is deployable on small 4WD vehicles. The system is intended to enable easy integration with existing and future C4I systems, for fast data dissemination as well as easy coordination between operational forces in the field.

Skylark : A family of highly portable, electrically propelled UAS that includes man-portable (Skylark I-LE) and vehicle-launched (Skylark II) variants, these drones are highly covert, inaudible even as low as 300-500ft above ground level. The electric propulsion also simplifies system operation and maintenance in the field, as no refueling and engine maintenance are required. The Skylark's streamlined gimbaled and stabilised triple sensor Micro CoMPASS payload includes a colour CCD day camera, a 3rd-generation thermal imaging night camera and laser illuminator. SkylarkII participates in IDF's border security operations, while Skylark I-LE (Long Endurance) is a derivative of the legacy Skylark I UAS and is the Israeli Defense Forces' battalion level UAS.

Universal Ground Control and Intelligence Management

Universal Ground Control Stations (UGCS) control Hermes 900 and Hermes 450 UAS, incorporating functionality derived from decades of UAS operations in Israel and capable of supporting all mission phases from planning and preflight checks, through mission execution, mission debrief and mission training. Elbit's UGCS is especially designed for maximal flexibility in incorporating various payload types, and data links and even other types of UAS. One UGCS is capable of concurrently controlling two parallel UAS missions using two Ground Data Terminals. Each basic mission can be fully controlled by a single operator, the high level of system autonomy enabling the operator to focus on mission execution rather than on flying the air vehicle. For example, the same operator can control both the air vehicle and the electro-optical payload, including slaving the air vehicle to the payload (fly-by-camera). The UGCS is capable of disseminating data and video via wirelessly to remote HQ or to other networked entities and can be integrated with a range of existing customer C4I infrastructure.

The Intelligence Management Centre augments the unmanned systems, making it possible to conduct coordinated missions of multiple UAS and other collection means, controlled by multiple ground stations, all managed by a common situation and management centre. The UAS management centre can provide commanders with data received by all deployed platforms and sensors. The mission commander is provided with an overall view, received from various intelligence gathering sensors, displaying aerial platform mission assignments and the combined tactical picture. The IMC allows rapid intelligence flow for improved overall mission efficiency. Mission instructions are sent by the commander directly to the UAS operators in the GCSs and video intelligence is displayed simultaneously on the mission station screens and at the management centre. All data received from the UAS can be transmitted to the external ground forces' C4I systems.

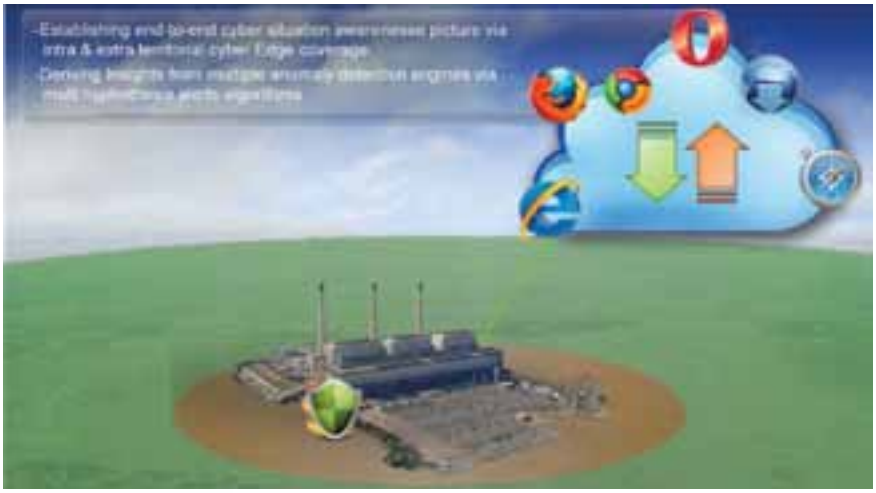
AvioHeliTronics

IAI's approach in countering cyber threat challenges

An increasing reliance on cyberspace exposes governments, militaries and commercial businesses to cyber fraud and sabotage. Emerging cyber threats, which are aimed against nation states, critical infrastructures, enterprises and private citizens, create an inherent asymmetry between attackers and defenders. The attackers – cyber criminals, insurgents and hacktivists – benefit from the ease of concealing and disguising identities within cyberspace, widespread availability of data encryption capabilities and the proliferation of cyber-attack capabilities, whereas the defenders are forced to detect advanced low-signal threats which, even after being detected, are seldom able to track their origin, and as such the defenders are unable to retaliate against assailants.

Skilled hackers, terror organisations and rogue states are currently developing sophisticated cyber attacks by implementing different aggressor techniques and methods that result in well-orchestrated attacks and security breaches. These highly invested targeted threats or APT (Advanced Persistent Threats) are built to exploit the organisation's vulnerabilities and stealthily prepare for malicious execution of a "kill chain" at the right moment. It is now evident that an efficient cyber methodology has to be able to combine Early Warning capabilities with active defence tools. It is essential to detect and track the threats as early as possible – raising the need for sophisticated Cyber Intelligence capabilities as an essential part of a nation's Cyber Defence Concept.

Israel Aerospace Industries (IAI) has accumulated more than six decades of expertise in innovative technological defence and intelligence systems. IAI's rich legacy in defence situation rooms, signal intelligence, communication and electronic warfare (ew) enables it to master and confront cyber challenges – applying advanced algorithms and tools to identify, and generate cyber situational awareness, allowing detection and mitigation of sophisticated cyber attacks.



Early Warning

In order to meet the ever increasing cyber challenges, IAI has designed a holistic approach, incorporating cyber intelligence along with cyber forensics and cyber security capabilities into a single unified framework. This approach allows an effective and efficient utilisation of resources, creates comprehensive cyber intelligence and defence pictures, and provides cyberspace intervention as needed. The framework is designed as an open, modular, flexible and hierarchical system and subsets and elements of the framework can be implemented as stand-alone components and integrated with other indigenous or third party systems.

As part of its innovative approach, IAI has established cyber centres of excellence, researching complex challenges in cyberspace and developing prototypes of advanced and innovative cyber solutions. These prototypes are then productised by IAI's experienced scientists, engineers and security professionals, into customer-grade products and solutions, coupled with the appropriate Standard Operational Procedures (SOPs). IAI's global network of maintenance and assistance ensures that all the proper training and support is provided to the customer.

IAI is investing a lot of effort into aiding customers with their capability build-up in the areas of cyber intelligence, defence and forensics. To that effect, IAI has developed a Cyber Range & Cyber Forensics Lab, combining commercial off the shelf (COTS) capabilities with novel statistical capabilities, as well as cyber forensics, operations research and impact analysis models. IAI concluded 2014 with cyber-solutions contracts totalling millions of dollars. Two significant contracts were signed with strategic, defence, foreign customers.

IAI has thus defined cyberspace as a strategic domain and one of the company's core areas of activity. Development of advanced cyber solutions for intelligence, protection, monitoring identification and accessibility is underway. These sophisticated capabilities are made possible by unique technologies developed by IAI's research, development and excellence centres. The company is offering numerous channels and dimensions for handling the various, constantly evolving cyber threats.

"The Cyber arena requires reliable, strong and experienced solutions' provider in order to allow appropriate, constant managing. We've harnessed the best minds and technologies to create a new approach, enabling our customers for optimal management of today and tomorrow's cyber challenges," said Esti Peshin, Director of cyber programmes at IAI.

OIS-AT

ADVERTORIAL

Eurofighter Typhoon

Eurofighter with Paveway guided bombs.
(photo: Jamie Hunter)

Interview with

Alberto Gutierrez, Eurofighter CEO

VAYU : Why is Eurofighter Typhoon exhibiting at Aero India 2015 ?

Gutierrez: The very fact that we are an exhibitor at Aero India 2015 underlines our commitment to India and the importance of this growing country. We decided to go for this Air Show to showcase our programme and the outstanding capabilities of our aircraft, demonstrating that Eurofighter Typhoon continues to be a global force. At the same time we are highlighting the fact that we have already delivered more than 420 aircraft to six customers

and the worldwide Eurofighter fleet has accumulated more than 274,000 flying hours. We have designed and produced a very innovative exhibition pavilion (called the 'E Cube') which distinguishes ourselves from all other exhibitors. In principal, we are here at Aero India to talk to any customer who is interested to learn more about our aircraft.

VAYU : How do you evaluate the possible chances that Eurofighter could become India's next combat aircraft?

Gutierrez: Referring to the current situation in India, we fully respect India's procurement process for the MMRCA competition. We were selected as being fully compliant and are still very confident that we can meet the requirements of the Government of India. You will not be surprised when I tell you that we are carefully monitoring the ongoing MMRCA negotiations with great interest and are ready to re-engage any time should the Indian customer invite us. And of course, we would be pleased to develop a long-lasting partnership with industrial companies in India. Defence companies in Germany, the United Kingdom, Spain and Italy are capable of making significant industrial contributions to the 'Make in India' initiative of the Indian Government and it would become a win-win-situation for both sides.

VAYU : Which other countries are in the focus of your worldwide sales campaigns?

Gutierrez: Looking at the global markets, we decided to focus our global sales activities on the Middle East and the Asia-Pacific region. We have contact with customers in Saudi-Arabia, Kuwait, Bahrain, Qatar, etc. in the Gulf region and Malaysia and Indonesia in South-East Asia who are interested to procure new combat aircraft. Most important for us is that we are not just interested in selling an aircraft but are fully committed in establishing long-term strategic partnerships with potential customers and develop long-lasting industrial collaborations between their industries and the Airbus Group, BAE Systems and Alenia Aermacchi/ Finmeccanica which are Europe's leading aerospace and defence companies. In addition to the Middle East and Asia-Pacific, we will continue the dialogue with our current customers in Germany, the United Kingdom, Spain and Italy and explore future market opportunities in European countries such Denmark, Finland and Poland.

VAYU : What progress have you achieved with the Capability Roadmap to enhance the operational capabilities of the Typhoon ?

Gutierrez: 2014 has been a successful year for us! BAE Systems completed the first in a series of live firings with the Meteor air-to-air missile manufactured by MBDA. This continues the series trials which demonstrate the integration of the Meteor onto the Eurofighter Typhoon. In November, Alenia Aermacchi conducted the first release of a Storm Shadow missile from a Eurofighter Typhoon as part of its missile integration programme. In December, BAE Systems completed the first full trial installation of the Brimstone missile, which significantly enhances air-to-ground capability of the Eurofighter. Six Brimstone missiles were fitted to the aircraft, each wing carrying a launcher with three missiles. In 2015 we will continue with our roadmap of capability enhancements and intend to launch the next enhancement phases. So all in all our programme is well on track. Eurofighter Typhoon is an extremely potent combat aircraft for the next decades to come.

VAYU : What is the latest on the E-Scan radar for Eurofighter Typhoon?

Gutierrez: We installed the new E Scan radar on an operating Instrumented Production Aircraft (IPA 5) for flight testing and showcased this aircraft during the Farnborough International Air Show in July 2014. We also signed a € 1 billion Development and Integration contract with NETMA in Edinburgh (Scotland) in November 2014 and I am convinced that the new radar will be available to satisfy the operational requirements and timings of all the Air Forces that are operating Eurofighter Typhoon as well as future Export Customers currently evaluating the aircraft. The E-Scan radar capability will further improve Eurofighter Typhoon's combat effectiveness, allowing the aircraft to maintain its superiority over other available combat aircraft.

New Controp products at Aero India 2015

Controp Precision Technologies a manufacturer of EO/IR defence and homeland security solutions, is demonstrating its recently introduced cutting edge *Micro-Stamp* dual sensor day/night stabilised miniature payload for small UAVs for the first time at Aero India 2015. The 300 gram advanced gyro-stabilised miniature payload is being supplied to the first customer.

"Following meticulous research and development, we are proud to demonstrate for the first time at Aero India 2015 the world's most advanced miniature payload of its kind. The *Micro-Stamp* was developed as a result of an operational requirement arising from the field. SUAV users required a very small and lightweight day/night payload with a superior level of gyro-stabilisation and a thermal camera with a dual field-of-view (FOV) and we're glad that we are able to provide them with this advanced solution," said VP Marketing Mr. Johnny Carni.

With a height of only 4", the *Micro-Stamp* provides a dual FOV uncooled IR camera and a day camera with a continuous zoom lens. Features include low power consumption, INS on the line of sight and an optional video tracker. "Already gaining customers, the *Micro-Stamp* generates a lot of interest from the users in the field, and we expect to receive more orders in the near future," added Mr. Carni.

In addition to the *Micro-Stamp*, Controp is demonstrating its *M-Stamp* lightweight gyro-stabilised multi sensor payload for small UAVs (SUAVs) and small aircraft. Weighing only 1.3 kg, the M-Stamp has a CCD with continuous zoom lens, uncooled IR Camera with state-of-the-art continuous zoom lens and laser pointer. Controp is also displaying the *T-Stamp*, a triple sensor EO/IR payload which is ideal for UAVs, VTOLs and a variety of other installations. The lightweight, three gimbal gyro-stabilised *T-Stamp* provides high resolution images and is available with 180mm focal length and improved DRI.

Also on display is Controp's flagship *DSP-HD* high definition, high performance EO/IR gyro-stabilised payload with up to five EO/IR sensors. The DSP-HD enables 24/7 long range observation. The DSP-HD includes a full HD color day camera and a thermal imaging camera, both with a continuous optical zoom, a color HD day spotter, an eyesafe laser rangefinder and a laser pointer. Weighing 29 kg, the DSP-HD is a four-gimbal, gyro-stabilised system that can be integrated onto a wide variety of air, land and maritime platforms.

Controp is highlighting its *Speed-LR* long range EO/IR day/night, gyro-stabilised system, ideal for the security of airports, coastlines, seaports and harbours. The system provides 24/7 automatic intruder detection and recognition and has proved itself in various operational applications worldwide.

Carni concluded by saying that "Controp's entire line of EO/IR systems is in daily operational use in dozens of different locations and applications worldwide, and receives high praises from its users. It is our policy to work closely and in cooperation with our customers in order to learn about their requirements and provide them with the most advanced solutions in this field".

Controp specialises in the development and production of electro-optical and precision motion control systems. the company's specialists have over 35 years of experience in EO / IR products.

Controp M STAMP Payload

Controp SPEED LR

Controp DSP-HD Air

Controp MICRO STAMP

Controp T-STAMP

2014: a year of records for Irkut

Su-30SM parked at a Russian air base (photo: Irkut)

Russian aircraft company Irkut Corporation has been constantly increasing production of military aviation products, and set a company record for deliveries in the year 2014. The firm ended the year with total deliveries of military aircraft standing at 50, the highest in post-Soviet times.

More than half this number is made up of aircraft from the Su-30 family of multirole fighters. The Su-30SM variant is an all-Russian derivative of the Su-30MKI, leveraging the development and proven abilities of this type in IAF service. Su-30SMs are being delivered in quantity to the Russian Navy and Air Force, forming the upper-tier of their multirole capabilities. In parallel, Irkut has continued to supply Su-30MKI knock-down kits for assembly by HAL in India.

Production rates of the Yak-130 combat training aircraft (lead-in fighter trainer – LIFT) have been boosted as well, with 20 units of the type delivered to the Russian Air Force, which has just set up a new combat training unit at Armavir air base (part of the 783rd training centre).

Looking to the future, Irkut appears set to maintain this momentum through 2015, targeting another jump in deliveries. It aims to increase production of Su-30 and Yak-130 aircraft, with Irkut President Oleg Demchenko stating that the firm predicts deliveries of about thirty Su-30 family fighters and approximately the same number of Yak-130s. Among the drivers of this fresh growth are new trends in marketing, and orders for military aircraft to be delivered to Russia's regional economic and military partner States. As an example, a contract for delivery of Yak-130 combat trainers for the Belorussian Air Force, a major Russian ally, is being implemented.

Russian experts are keen to stress on the fact that the increased production of military aircraft at Irkut is taking place on the eve of series production of the MC-21 narrowbody airliner, which they say bodes well for the firm's ability to maintain output. "Professionalism of our employees and upgraded production capacities allow us to increase output of military aircraft in parallel with production of the first MS-21 passenger aircraft," said Oleg Demchenko. The MC-21 is Irkut's new generation airliner, first prototype of which is to be assembled by the end of 2015.

Work underway at the Su-30 production line (photo: Irkut)

An airframe part waiting to be integrated at the Irkut plant (photo: Irkut)

The C-Dome Naval Point Defence System

VAYU Interview with

Rafael's President and CEO Vice Admiral (Ret.) Yedidia Yaari

***VAYU*: Rafael recently secured a massive order to supply man-portable ATGMs to the Indian Army. Please elaborate on how you propose to meet Indian production and technology transfer aspects of this order.**

YY: Although we have not yet fully finalised the contract, we are indeed very pleased about the Indian Army having selected the Spike missiles as its next ATGM missile.

As you know, the Spike Missile Family consists of precise Tactical Missiles for ranges between 200 – 25,000 m. The Spike Family is a multi-purpose, multi-platform electro-optic missile system with real time data link. The Spike missiles are in use by infantry units as well as mounted on combat vehicles, attack helicopters and naval vessels. The Spike missiles are combat proven and in service in many countries, including Italy, Germany, the Netherlands, Spain, Poland and others.

The missiles in this family have sophisticated electro-optic CCD or IIR sensors for day/night all-weather operation, as well as a tandem warhead. Their lofted trajectories enable the warhead to strike the target at its most vulnerable location with pinpoint precision. All of the SPIKE Family members have a low life-cycle cost, due to high reliability and operational and logistic support and production commonality between members.

There is no doubt that we will collaborate with the Indian defence industry on the production of the Spike missile. Our goal and aim is to deliver the Indian armed forces an *Indian Spike missile*. We are negotiating with the local companies to find the best way to execute our plans. Rafael is a team player and we have already proven the ability of transferring technology as well as meeting the offset requirements.

VAYU: What bearing, if any, will this recent success have on any proposal to supply air-launched ATGMs for the Army and Air Force's combat helicopters?

YY: As mentioned, one of the Spike missile advantages is its being part of a family of missiles that give the users cost effectiveness with life cost and commonality. The Spike-ER is an extended-range, multi-purpose anti-armour missile system designed for operation from various platforms, including helicopters, fast boats and combat vehicles. It can also be mounted on a tripod for ground operation. Spike-ER is capable of defeating targets at a range of up to 8 kilometers. Spike-ER features a day and night seeker, tandem warhead, and retains the dual operation modes of Spike : Fire and Forget, as well as Fire, Observe and Update. This enables the gunner to switch between targets after launch, avoid friendly fire, conduct surveillance/damage assessment and attack hidden targets. Spike-ER additionally features a Fire and Steer mode, in which the gunner can launch the missile without pre-locking onto the target and manually steer it to the target (LOAL). Spike-ER can be equipped with a variety of warheads for a broad range of combat scenarios including, urban settings, anti-terror missions and low-intensity conflicts.

VAYU: India's Arjun MBT already incorporates a slew of Israeli systems. Has there been any interest from the Indian Army for active protection systems, such as Trophy, to be installed on the Arjun, or any other active MBT type?

YY: Rafael has advanced and combat proven armour protection systems with all protection technologies: passive, reactive, hybrid and Active Protection systems. Rafael conducts development, design, integration and production of the most advanced armour systems to enhance the protection level of armoured vehicles. Rafael uses its extensive experience to provide high level of protection, lightweight and low cost enhancements integrated on all types of combat platforms. All armour products are modular and capable of protecting combat vehicles from a broad range of threats such as small and medium kinetic energy (KE) armor piercing (AP) projectiles, high energy anti-tank Shaped Charges (SC), high speed fragments of artillery and Improvised Explosive Devices (IEDs) and Explosive Forming Projectiles (EFPs).

We offer the Trophy active armour protection system, the only operational, combat-proven armour APS in the world. Merkava-4 tanks integrated with Trophy active protection systems are presently deployed in combat areas along Israel's borders. The Trophy system is adaptable to any combat platform. Once a platform is chosen, a short trade study is completed to work out any integration issues that may arise. Numerous elements are taken into consideration for each vehicle variant or type. For vehicles with relatively basic or light armour, (e.g. the Stryker), the Trophy provides full protection against all types of RPGs (as well as other threats) due to the fact that the Trophy destroys these types of threats without detonation.

Trophy

VAYU: What is the extent of the role Rafael has in integrating and clearing the HAL Tejas LCA to use the Derby as its BVRAAM option? Will any other Rafael weapons be integrated with the Tejas?

YY: The Derby is an active radar air-to-air missile that provides fighter aircraft with outstanding and effective performance in both short ranges and Beyond Visual Range (BVR) intercepts. The missile enables operational flexibility and multi-shot capability. It can be launched at an enemy aircraft day or night and in all-weather conditions. Additional Derby capabilities include look-down/shoot-down, sophisticated fire-and-forget mode and an advanced ECCM tailored to the customer's operational requirements. For the time being, the Derby is the only Rafael system that has been integrated for the HAL aircraft.

VAYU: With a new government and a very different defence posture, not to mention a fresh focus on indigenous production, what challenges and opportunities do you foresee going forward in India?

YY: As I mentioned at the beginning, Rafael has identified many cooperation opportunities with the local industry and we will do so through joint ventures and teaming agreements. We are offering India our advanced proven systems and capabilities in the defense area, as well as in the areas of safety and security, and we do hope to enlarge our activities here.

VAYU: What are the main focus areas for Rafael at this year's Aero India?

YY: At Aero India 2015 we will present a wide range of systems and capabilities. Rafael's systems are *Discriminate*, *Precise* and *Proportionate*, and this in turn makes them *economical*, *efficient* and *effective*. At Aero India Rafael will present complete aerial and air defence systems.

For the first time in India, Rafael will unveil C-Dome, a Naval Point Defence System based on the combat-proven Iron Dome. In addition, Rafael will present, for the first time in India, Spice-250, the new generation standoff Precision Guided Munition (PGM) based on Rafael's unique scene-matching technology used in its already combat proven Spice-1000 and 2000 guidance kits. Among its other advanced defence systems, Rafael will display: Integrated Air and Missile Defence Systems (Iron Dome, Spyder SR/MR, Python–5, Derby, MIC^{4}AD, Spice 2000); Electro-Optic and Communication Systems (Reccelite & Recce-U, Litening, Toplite EOS, BNET SDR Family) and multi-purpose, tactical guided missile systems: Spike MR, ER, NLOS.

Thales JVs in India

Partners in progress

IAF Mirage 2000s are being upgraded (photo: Angad Singh)

Thales is a global technology leader in the aerospace, transportation, defence and security markets and has been present in India since 1953. With its 25,000 engineers and researchers worldwide, Thales has the unique capability to design, develop and deploy equipment, systems and services that meet the most complex security requirements. Thales has an exceptional international footprint, with operations around the world working with global and local partners.

In India, Thales has been co-operating with numerous large corporate players in the private space and SMEs to build transfer of technology and supply chain partnerships.

For decades now, Thales has been offering the full scope of its defence expertise and experience to the Indian Armed Forces. In July 2011, Thales and Dassault Aviation signed a contract for upgrade of the Indian Air Force's Mirage 2000 fleet in view of enhancing its technical-operational capabilities. The company has also signed major contracts with the Indian Ministry of Defence for radars and systems such as Flycatcher Mk1 as well as state-of-the-art AESA radar such as LLTR's GS100 for the Air Force; reconnaissance pods Vicon 91 for the Air Force; avionics and INGPS for military aircraft such as the Mirage 2000, MiG-21 and 27, Su-30; electronic warfare (EW) systems for Indian Army and Navy; anti-submarine warfare sonar systems and mine-hunting solutions for the Navy; long-range surveillance radar for Navy, among others.

Originally, Thales focused on defence in India. However, in the late 90s, it extended its footprint to other key areas such as ground transportation and aerospace. In main line transport, Thales was the first to introduce digital axel counters on the Indian railways network in 1999. In September 2014, Thales won a contract from Southern Railway to supply an ETCS Level 1 signaling solution (known in India as Train Protection and Warning System - TPWS) on the Basin Bridge-Arakkonam section. This is the first ETCS contract awarded to Thales in India, and also the first step of a large modernisation programme of TPWS systems on the Indian Railways network. As for the metro rail, Thales has had several successes including communication and supervision systems for the New Delhi, Mumbai, Jaipur, Hyderabad and Bangalore metros, and advanced CBTC signalling for the Hyderabad metro. Recently, Thales has won the contract to provide Automatic Fare Collection (AFC) systems for Phase II of Rapid Metro Gurgaon (operated by IL&FS Rail Limited – IRL), which connects to the Delhi metro. It has also been awarded a project to provide Automatic Fare Collection (AFC) systems for Phase III of the Delhi Metro. Phase III, which covers 140 km crosses the city centre and includes extension to satellite towns.

In the aerospace domain, Thales' in-flight entertainment system makes the journey easier for passengers travelling by Air India. The company has also supplied avionics to most of public and private airlines in India.

Thales's strategy of developing its industrial footprint in India is in line with the Indian government's policy to develop the industrial defence base of the country. With this as the backdrop, Thales has formed Joint Ventures with BEL and SAMTEL along with L&T Technology Services. These JVs reinforce company's commitment to the country.

Ever since it set up India operations over 60 years ago, Thales has been forthcoming in partnering with Indian industry and sharing knowledge, technical know-how and expertise. Its association with BEL also dates back to around this time.

Similarly, for over 50 years now, Thales has been closely working with Hindustan Aeronautics Limited (HAL), in all technological areas that can be used for military aircraft. The two companies collaborated on six fixed wing and rotary wings military aircraft programmes and are in active discussion for several other military air platforms.

The company has over 300 employees in India across its offices in New Delhi, Bangalore, Hyderabad and other cities. It looks forward to develop local skills and capability, especially in engineering and business related domains.

A very important aspect of the company's growth strategy is localisation, projecting Thales' technological expertise from the domestic country onto the local industry here. Thales plans to expand locally in India through its wholly-owned subsidiary Thales India Private Limited, JVs and all the partnerships with the local industry that can be envisaged. The company has identified over 50 offset partners in India. Some of those we are currently working with, for various projects, include Hindustan Aeronautic Limited (HAL), Bharat Electronics Ltd (BEL), BEML, among others.

Antoine Caput, VP & Country Director, Thales India

The Flycatcher radar system

Kishore Jayaraman, President, Rolls-Royce India and South Asia on

Roll-Royce on Powering India's Infrastructure and Defence Modernisation

Sweeping changes and developments have marked recent past of the Indian defence and aerospace industry, eventually contributing to the infrastructural and modernisation needs of the nation. The 'Make in India' campaign carries the potential of augmenting manufacturing in the defence sector from present 30% to a whopping 70%. Rolls-Royce supports this progressive initiative as it will not only help Indian industries become globally competitive but will also allow multi-national companies to further support the country's modernisation needs.

The Adour engine powers both the Jaguar and Hawk with the IAF

In the last national budget, the FDI limit in defence sector was increased to 49% from 26% to help attract greater foreign investment into the sector. As per recent reports, the Indian aerospace and defence opportunity will grow at a compounded annual growth rate of 13.6% to become a $70 billion market by 2018. This will open prospects for joint ventures and boost public private partnership. Steps such as these eventually help the country attain strategic self-reliance.

Defence technology comes with huge investments in Research & Development. From a strategic point of view, there is a need for upgrading defence resources either by developing or procuring defence equipment and systems. Currently, India imports 70% of the equipment needed. However, the government is now aiming to reverse this balance. The Indian defence and aerospace sector is projected to offer US $ 200 billion business opportunity in the next decade and a half. Upgrading and maintenance of existing equipment will also provide plenty of opportunities to the industry.

Although lately, the private sector is playing a significant role as sub-contractors and subsidiary industry, and suppliers of raw materials, a new style that leverages the strengths of public and private partnerships needs to be evolved to achieve self-reliance in defence production. There is an upright balance between where the country wants to go in terms of defence procurement and support, and what we at Rolls-Royce can offer in terms of engines and services.

The mainstay of any sector is its human resource - the skills and technical abilities of the workforce. For matching the skill set with employable talent in the Aviation and Defence industry, there is an imperative need to recognise country's existing skills and competencies in areas such as quality production, precision engineering, and the likes. Considering this is a very niche sector, it's important to develop training grounds to meet prospective manpower requirements in the sector.

Today, there is a vacuum between the theoretical and hands-on knowledge and this gap has to be bridged. A close alliance between the industry, academia and government needs to be formed to address the concerns at the basic levels, such as, skills development, curriculum content, etc. While India produces over a million engineers every year, in today's competitive knowledge driven environment, the quality of workforce becomes the priority rather than the quantity.

With over 80 years of journey, Rolls-Royce has endeavoured to deliver the government's vision, and support India's infrastructure and modernisation needs. Our IAMPL facility (International Aerospace Manufacturing Pvt Ltd), a joint venture with HAL, produces shrouds and cones for the Trent family of engines, and is our commitment to the vision for the future. Rolls-Royce's partnership with HAL has also been instrumental for the future of the Indian aerospace industry. The new government has already led to tremendous positivity for progress, and the 'Make in India' programme will further build on this momentum and push India towards greater heights. At Rolls-Royce, we are well poised to cater to the growth opportunities available in the India region. We look forward to continue to offer India a unique combination of technology, experience and innovation that can help to improve the capability of our customers.

At Rolls-Royce, we are committed to delivering the government's vision of positioning India as a global manufacturing hub. We already have 1000 local engineers working in India through outsourced agreements and have world-class manufacturing facilities here, exporting components around the world. We have grown from licensed production and engineering services to component manufacturing and supply chain. We now need to extend this experience into defence, beyond today's licensed production. Going forward, we are passionate about making India a hub for Rolls-Royce defence engineering, manufacturing and export as it will not only help create jobs but also supports India to achieve strategic self-reliance. With India's focus on strong economic and infrastructure growth, Rolls-Royce is well positioned with its broad range of products and services to meet the needs and help achieve long-term growth for India.

Trent 700

Safran and 'Green Engines' - The Future of Civil Aviation

Rising pollution levels, environmental regulations and ever rising fuel costs are factors that are pushing the aviation industry to develop products that reduce emissions and noise pollution. Over the past 60 years, the aviation industry has made remarkable strides, reducing carbon emissions by 70 percent and noise emissions by 75 percent. Yet, challenges are many!

Airlines today are faced with a dramatically changing business landscape, largely because of volatile jet fuel prices. Airlines in India, in particular, face questions about their immediate and long term solvency. However, the situation is not all that dire. There are short-term strategic actions concerning business models and investments that airlines can take to gain an advantage over their competitors and ensure their own viability. Airlines must reduce their consumption of oil-based jet fuel by investing in more fuel-efficient technologies, nurturing the growth of alternative energies, and, more immediately, optimising their business models. Doing so not only saves the industry billions of dollars but also helps airlines achieve a sustainable and lower emissions future.

The Indian aviation sector is going through a tectonic shift in terms of technology. Innovative engines are being adopted to improve financial and environmental sustainability. The holistic focus is to augment the performance and efficiency of the engines. India as a market is touted to become the global leader in the aviation sector by 2030 and hence technological innovations like these would be needed to make the sector sustainable and tenable. Transfer of technology through International synergies is propelling this gargantuan trend of sustainability. Green engines are the future of aviation technology, the next generations engines will be more fuel efficient and high on environmental performance.

Some developments in the Airline Engine industry with a potential to transform the aviation industry into one of the greenest modes of mass transportation on earth are as follows :

LEAP, the engine of the future

Leap is a new-generation engine designed and developed by CFM International, the 50/50 joint company of Snecma (Safran) and General Electric, through a very technologically ambitious development program. The new Leap engines incorporate a number of innovative technologies developed through the Leap research and technology program. It is mainly designed to power the next generation of single-aisle commercial jets.

Leap features a host of advanced technologies to help reduce its fuel consumption by 15%, nitrogen oxide emissions by 50% and noise to 15 decibels. Thereby, there will be fewer and lighter fan blades, since they are made of composite materials using a proprietary woven 3D RTM (resin transfer molding) process. The use of these new composites on fan blades and other components would reduce the weight of each aircraft by about 1,000 pounds (450kg) and would increase the overall performance levels. These improvements translate to savings of 0.5l/100km per passenger. For a 150-passenger airliner, that equates to 22 of those passengers flying without consuming fuel!

The fuel savings will also result in 4,000 tons of CO_2 emissions saved each year. When replacing older engines, that number could be as high as 6,000 tons per year. In fact, if these numbers were applied to the entire CFM56 fleet, this could lead to more than 40 million tons of CO_2 emissions saved each year.

Open Rotor type engine

Under Clean Sky 2 programme of the European Union, Snecma (Safran) is developing an Open Rotor demonstrator that will bring a clear cut advancements from today's jet engines architecture. This engine is intended to power the single-aisle jets that will enter service in 2025-2030 and is a radical concept with counter-rotating high-speed propellers. The Open Rotor engine concept is designed to significantly increase the propulsion efficiency of jet engines, by increasing the airflow around the engine (it is also known as an ultra-high-bypass concept). The benefits of this type of architecture include a 30% to 40% reduction in fuel burn per seat (depending on aircraft design and operation), in relation to the turbofan engines now in service.

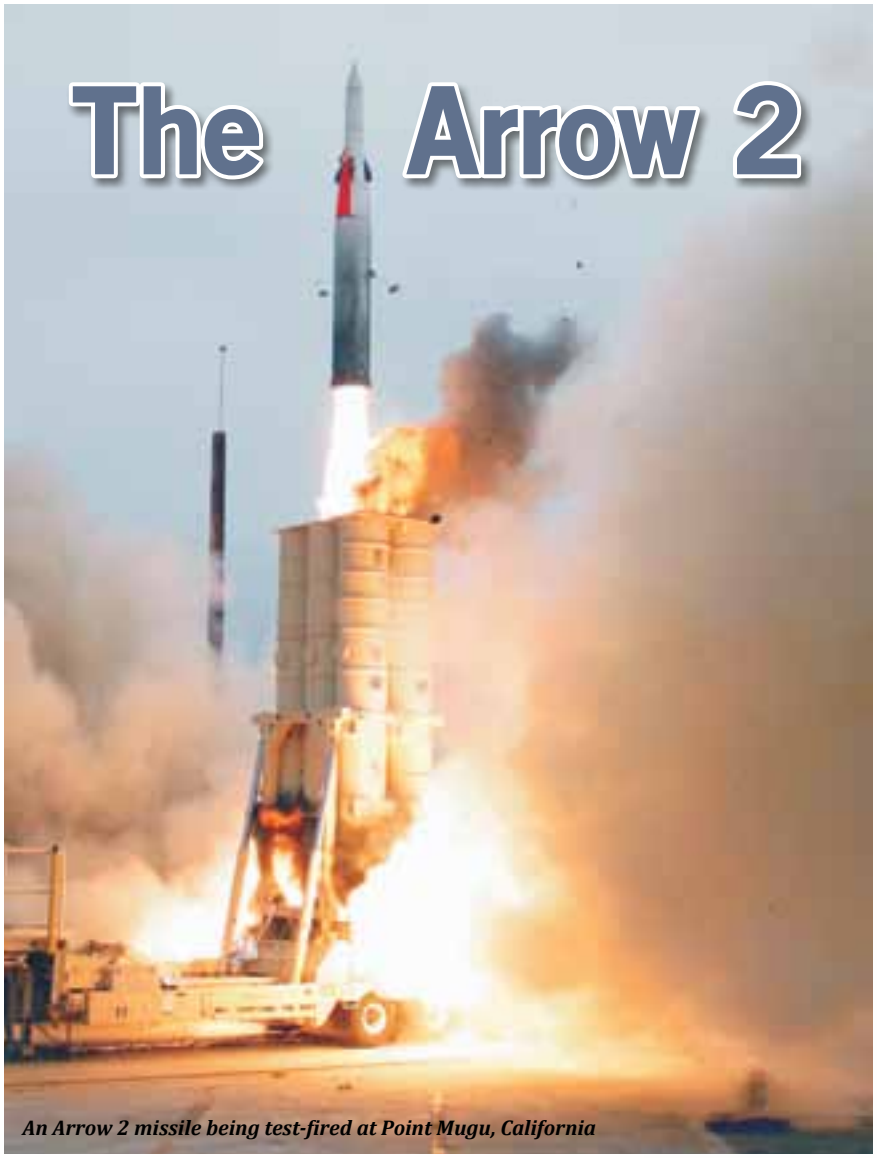
Carbon Mitigation though Biofuels

Over and above the ongoing improvements driven by technological innovation, the use of sustainable biofuels will play a critical role in meeting the ambitious objectives set by the air transport industry. Many companies engaged in aviation technology development, including Safran, are taking an active role in research, as well as the ground and flight testing of biofuels that could contribute to the sustainable development of air transport, based on a favorable carbon budget, without impacting agrifoods resources.

The Indian aviation sector has been predicted to become the world's third largest by 2020. It is shortly expected to carry 460 million passengers per annum. A sector of such magnitude needs to be environment friendly. The International Air Transport Association has declared to cut its carbon emissions to 50% by 2050. These environmental obligations coupled with financial pressures of running airlines in highly competitive market like India make for a compelling case for airlines in India to encourage and adopt green engines and green technology.

Article by : Stephane Lauret, CEO of Safran Indian Private Limited

The Arrow 2



An Arrow 2 missile being test-fired at Point Mugu, California

Undergoing Lethal Evolution

Israel faces the grim prospect of potential Tactical Ballistic Missile (TBM) strikes with Nuclear, Biological or Chemical (NBC) warheads not only from adversary nations but also from 'non-state actors' (read: terrorist groups) that could be supplied with Scud-type TBMs by 'sponsor' nations.The Israeli Defence Force (IDF) tackles such threats via deployment of a combination of Ballistic Missile Defences (BMD) systems. The IAI/Boeing Arrow 2 Anti-Tactical Ballistic Missiles (ATBM) developed by the MLM Division of Israel Aerospace Industries (IAI) presently forms the centrepiece of Israel's layered strategic missile defence system, called 'Homa.'

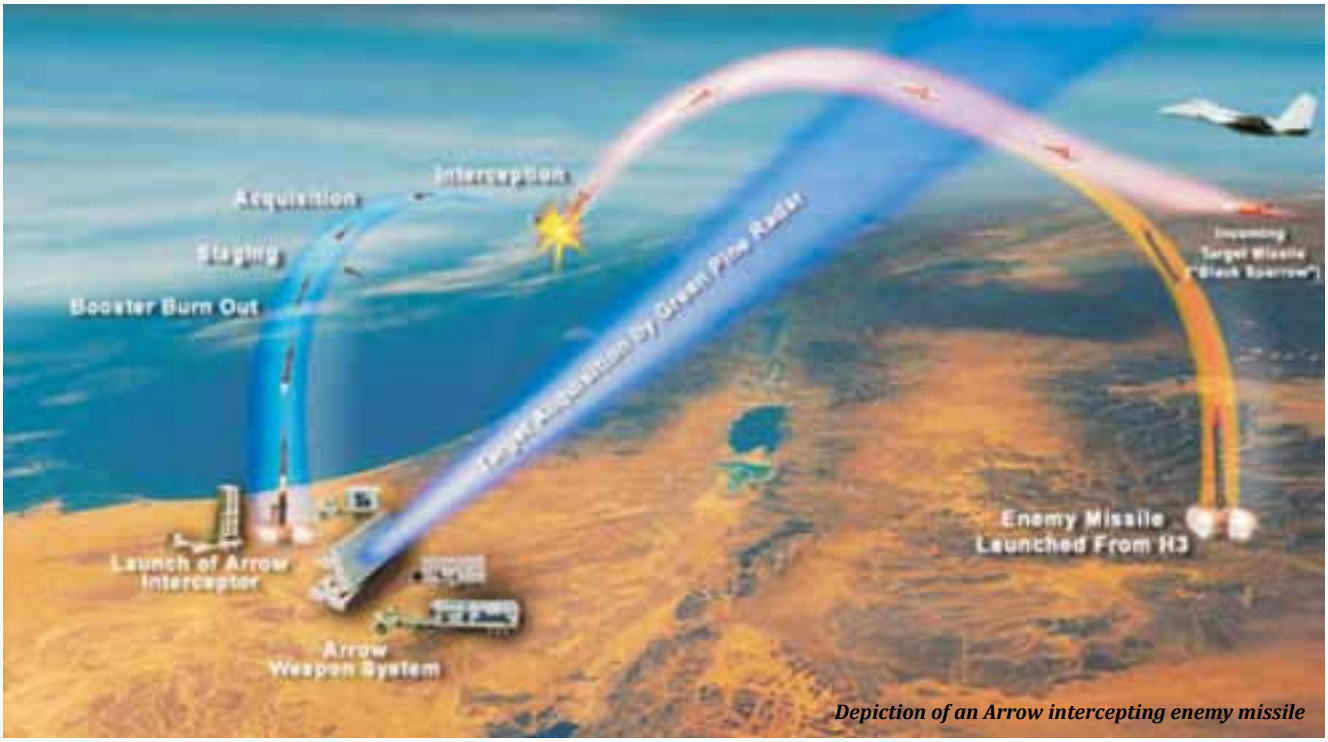
The first battery near Tel Aviv became operational in 2000 followed by another south of Haifa in 2002. They are deployed in such a manner that the coverage of the systems overlaps over vital military, commercial installations and concentrated civilian population. Deployment of a third battery is presently under consideration. The system, virtually forming a National Missile Defence (NMD) in the Israeli context, is stand-alone yet integrated with national command and control, and has the capability to provide early warning for itself and toengage multiple threats simultaneously.

In Israel, Arrow 2 functions as the upper tier of a multi-level combined air defence/ATBM network. The lower tiers consist of US and Israeli Patriot PAC-2/PAC-3 missiles,US Navy ship-based AEGIS systems, the David's Sling Weapon System (DSWS) and the Iron Dome.

The refined and leaner (1,300kg) Arrow 2 was first tested in 1995, being derived from 'Chetz' (Arrow) 1, a project initiated by the United States Strategic Defence Initiative (SDI) to be developed by IAI. Arrow 2 is meant to intercept tactical ballistic missiles just as they begin re-entering atmosphere after reaching the highest point in their flight trajectory. In February 2003, IAI signed an agreement with Boeing to establish the production infrastructure to manufacture components of the Arrow missile in the the United States, with Boeing responsible for the production and co-ordination of approximately 50% of the missile components in the United States while IAI undertakes integration and final assembly of the missile in Israel.

Under the Arrow System Improvement Programme (ASIP) being carried out jointly by Israel and theUSA's Ballistic Missile Defence Organisation (BMDO), a real (as against simulated) Scud-B Short-Range Ballistic Missile (SRBM) was successfully intercepted and destroyed at an altitude of 40 km at Point Mugu naval test range in California in July 2004. In December 2005, an Arrow 2 Block 3 missile successfully intercepted a target at an unspecified but reported record "low altitude." In February 2007, the system successfully intercepted and destroyed a Rafael Black Sparrow target missile, simulating a ballistic missile at "high altitude." On 7 April 2009 the Arrow 2 Block 4 was successfully tested against a compact Blue Sparrow target missile, which simulates more agile ballistic missiles such as the Iranian Shahab-3.

An Arrow battery is typically equipped with four to eight launch trailers, each with six ready-to-fire missiles, a truck mounted Hazelnut Tree Launch Control Centre (LCC), a truck mounted communications centre, a trailer mounted Golden Citron Tree Fire Control Centre (FCC) and the units of a mobile Green Pine early warning radar system. There are microwave and radio data and voice communications (Link-16) between the LCC and the radar command & control centre with the launch system deployable up to 300 km from the site selected for the radar command



Depiction of an Arrow intercepting enemy missile

& control centre offering unparalleled protection and flexibility to the Arrow Weapon System (AWS).

The two-stage Arrow 2 ATBM is equipped with solid propellant booster and sustainer rocket motors. Arrow 2 is launched vertically, separately or in salvos, giving 360-degree coverage to each battery. The Green Pine L-band, phased array, dual-mode (detection and fire control) radar determines the intercept point thereby up-linking very accurate data to the Arrow 2 guiding the intercepting missile to within 4 metres of the target.

The Green Pine

IAI's Elta EW subsidiary developed the EL/M-2080 Green Pine Early Warning & Fire Control (EW&FC) radar for the Arrow system. The Green Pine radar has a proven track record demonstrated in over twenty successful ballistic missile intercepts. The radar includes the trailer mounted antenna array, the power generator, a cooling system and a control centre. Developed from the Elta Music phased array radar, Green Pine is an dual mode, electronically scanned, solid state, phased array radar operating in the L-band (500 to 1,000MHz), weighs 60 tonnes and comprises 2,000 transmit-receive modules. Green Pine is said to be capable of tracking ballistic missiles from a range of up to 500 km and is able to track targets up to speeds over 3 km/s while intercept of the attacking missile may occur 90 km away at an altitude of 10 to 50 km. The long range of Green Pine radar system ensures that a second shot can be taken at the incoming ballistic missile if the first shot fails to secure the 'kill.' The ballistic missiles are again intercepted at a much higher altitude to prevent them from disintegrating as they approach lower altitude, thus 'faking' multiple targets on radar screens. Israel also receives data from the United States Defence Space Programme (DSP) early warning satellites and Boeing RC-135S Cobra Ball intelligence aircraft capable of picking up rapid movement or a rocket launch flash. Interestingly India placed an order for and received its first Green Pine EW & FC radar in 2001 which has since been integrated with the country's indigenous missile defence system as the *Swordfish* radar system. Two sites are currently operational – northeast of Bengaluru, and on India's northeast coast. The Green Pine radar's strategic value along the Indian-Pakistani border is well appreciated covering all of Pakistan's military command centres and bases between Islamabad, the capital, and the Indian frontier reportedly providing India with surveillance of Pakistan's nuclear centres and missile sites and relevant Telemetry Intelligence (TELINT) data. An enhanced version of Green Pine was the key to India's first Prithvi BDM test (see *Vayu* I/2007). The enhanced Super Green Pine pushes the tracking range to 800 to 900km.

Meanwhile the United States and Israel continue development of an upper-tier component (including an exo-atmospheric interceptor) to the Israeli Missile Defence architecture, commonly known as Arrow 3, based on an architecture definition study conducted in 2006-2007, determining the need for the upper-tier component to be integrated into Israel's Ballistic Missile Defence system in addition to Arrow 2 Block 4 ATBM. The KV of Arrow 3 is to be propelled by rocket motor and equipped with flexible nozzle to offer exceptionally large divert capability, while the gimballed seeker will obtain hemispheric coverage. By measuring the seeker's line of sight relative to the vehicle's motion, the KV would employ 'proportional navigation' deflecting the KV to divert its course and align exactly at target's fight path, hence achieving an accurate kill even at very high closing speeds and over long distances. Arrow 3 and Arrow 2 Block 4 are expected to form the top and upper layers, with the Rafael David's Sling providing the mid-tier and lower tiers, defending against tactical missiles, long range rockets, cruise missiles and attack aircraft. The low-level will be protected by Rafael's Iron Dome, countering short-range ballistic projectiles.

Sayan Majumdar

Honeywell at Aero India 2015

Honeywell is showcasing a wide range of technology at Aero India 2015, in addition to having senior management present to interact with Indian customers and press at the show.

Honeywell's association with India goes back over 40 years ago, with the company beginning its relationship with Hindustan Aeronautics Limited (HAL). According to Honeywell "the firm is committed to continuing to advance India's indigenous technology, from development through to production." India is already the global manufacturing base for the TPE331 engine, which powers the Dornier 228s used by the Indian Air Force, Navy and Coast Guard and others, with HAL manufacturing the engine type for domestic and international customers for over 25 years. Honeywell engineers across the country develop and manufacture products in use across many aspects of military and civil aviation, not only in India but in other countries around the world as well.

Honeywell is also taking advantage of a new business climate in the country and is expanding its partnership strategy in India. The firm recently signed a technology transfer deal with Tata Power SED, enabling the latter to produce the TALIN navigation system under licence, making this the first time that inertial land navigation technology will be produced in India. The agreement with Tata supports the 'Make in India' priority of the new government and provides Tata with a licence for the design, hardware and expertise to assemble, test and, in the future build production kits for TALIN.

Recognising the importance of the 'Make in India' programme, Honeywell is espousing a strategy of continued investment, creation of high technology jobs, global centres of excellence and local skill development in the country.

[Honeywell is exhibiting at Hall E, stand number E 3.18 at Aero India 2015]

A pair of Honeywell TPE331-5s on an Indian Navy Dornier 228 (photo: Angad Singh)

One of the first Dornier 228s (with Honeywell TPE331-5 engines) in south Asia first flew with Druk Air of Bhutan which later sold this aircraft to Jagson Airlines of India

Honeywell and Tata Power SED sign licence manufacturing agreement

Honeywell Aerospace has signed a licencing agreement with Tata Power's Strategic Engineering Division (SED), enabling the latter to produce Honeywell's Tactical Advanced Land Inertial Navigator (TALIN) system in India. This technology enables vehicles and artillery to navigate extremely precisely, even where GPS satellite guidance is not available, increasing ground forces safety and maximising mission success.

"Our strategic agreement with Honeywell supports Tata Power SED's commitment to the 'Make in India' initiative – a priority for India's new Government," stated Rahul Chaudhry, CEO, Tata Power SED. "We are proud to have completed this technology sharing arrangement, which will offer the Indian Armed Forces a state-of-the-art inertial navigation technology, made in India and with local product support. This agreement sets the standard for locally produced defence technologies to sustain India's military growth and mission success over the coming years."

Honeywell will licence the design, hardware and expertise to assemble, test and, in the future, build the production kits for TALIN to Tata Power SED. This will mark the first time India has produced inertial land navigation technology, providing the Indian Armed Forces with a locally constructed advanced land navigation technology that is not limited by a reliance upon GPS — an important benefit for vehicles and artillery operating across the country's mountain, desert and forest terrain where satellite signals can be limited. TALIN is a highly accurate, shock-stabilised position and pointing inertial navigation system designed for use on a wide range of military and commercial platforms. It provides users with extremely precise attitude and position awareness with or without the use of GPS. Using the same Ring Laser Gyro (RLG) and Quartz Accelerometer technologies with proven maturity across commercial and military navigation applications, more than 15,000 systems from the TALIN family are currently operating on more than 60 military and commercial platforms worldwide.

"TALIN represents the latest in GPS-free navigation and positioning technology, designed to improve asset safety and ultimately mission success," said Arijit Ghosh, President India, Honeywell Aerospace. "By partnering with Tata Power SED on the production of TALIN we are aligning with the Government's aim of increasing locally manufactured technologies for India's defence industry and giving the Indian Armed Forces an easy-to-justify option for navigation on the 21st Century battlefield."

The initial efforts will begin in 2015 for the TALIN 2000 with production and manufacturing of the system components expected by 2016. At this time the agreement will also be extended to cover Honeywell's TALIN 3000, 4000 and 5000 products, which offer expanded capabilities to suit a range of operational requirements.

Make-In-India : BRAHMOS lays groundwork for the future

India is certainly moving in the right direction as concerns defence indigenisation. With the Government's ambitious objective 'Make-In-India', the euphoria is steadily galvanizing the Indian defence industry in big manner, with both public and private sector entities planning to conceive, design, develop and produce state-of-the-art modern military systems which would make India a world leader in this field.

Defence technology has always been considered a strategic asset for any nation, with only a handful of countries capable of producing high-tech weapons, systems, and platforms. This strategic area has been dominated for many decades by the two leading global powers, the USA and Russia, the two arch rivals competing to outpace each other in developing and producing advanced defence and aerospace systems.

A number of European countries, including the UK, France, Germany, Sweden and Italy have also invested in high-tech defence programmes, independently as also in partnerships. Israel too has gained expertise in developing and producing sophisticated weapon systems.

In Asia, the lead in defence production in recent years has visibly been taken by China, which has, according to military experts, reverse-engineered most of its military hardware and systems. Japan and South Korea have also endeavoured to develop certain defence systems indigenously, as also on partnership basis.

For its part, India has over decades focused on building its own defence industrial base despite the restrictive technology denial regimes imposed by certain developed nations. In the face of many adversities, India has risen to a respectable position, acquiring critical military technologies in several areas, including warship building, aircraft and missile systems, armoured fighting vehicles, electronic warfare systems, radars and sonars, unmanned vehicles, advanced computing, networking and simulation for the Indian armed forces.

The task, however, is long, arduous and never-ending. Technology is ever-changing and keeping pace with this swift change is a challenging task. When it comes to gaining expertise in a critical asset like defence technology, it often becomes imperative to form alliances and partnerships for obvious reasons that such expertise demands huge investments, highly-skilled workforce, uninterrupted Research & Development work and infrastructural set-up.

Even as the Government's ambitious 'Make-In-India' campaign gets fresh impetus, the one missile system that has distinctly stood out as a most shinning example of a successful military collaboration programme between trusted allies, India and Russia, is the BrahMos supersonic cruise missile regarded as the "world's best", synthesizing the finest scientific minds from the two partnering nations to produce this formidable weapon.

Sudhir K. Mishra CEO & MD, BrahMos Aerospace, Outstanding Scientist & CC R&D, DRDO

While much is being discussed about the Transfer of Technology (ToT) clause in defence deals, in the BrahMos JV, the equation is actually on a 'equal partners, equal stakes' basis. The JV partners in this supersonic cruise missile programme have worked hand-in-hand in designing, developing, producing, testing and delivering this high-technology weapon to the Indian Armed Forces within a very short time span.

While Russian expertise has contributed in designing and developing the critical propulsion systems, which is the ramjet engine technology and booster for the missile, the Indian scientific community has immensely contributed in developing several key components, including the fire control, electronic and guidance systems, avionics and materials for airframe of the tactical weapon.

In fact, the JV programme is a perfect example of PPP (Public-Private Partnership) model. Based on the unique model of 'Missile Industrial Consortium', the BrahMos has brought together several public and private sector firms from both India and Russia that which has greatly contributed in making the missile a formidable weapon. Initially conceptualised as an anti-ship cruise missile system, BrahMos has gone on to prove its credence as a versatile, multi-platform, multi-target weapon, powerful enough to strike at the enemy anywhere, anytime.

To keep pace with ever-evolving military technological advancements, the BrahMos JV has also set its sights firmly on the future, with its 'Vision 2050' roadmap focused on designing and developing even more advanced variants of the supersonic cruise missile system. In fact, the 'Make-In-India' campaign has once again unfolded a plethora of opportunities for the India-Russia JV programme to move further and reap immense mutual benefits by bringing in cutting-edge technological advancements from both the partnering nations, culminating in the design, development and production of more advanced, futuristic variants of the world-class missile, which will be BrahMos Next-Generation (NG) and Hypersonic BrahMos II, to endow great lethality in the battlefields of tomorrow.

HAL

Interview with Pratyush Kumar, Boeing India President

What is Boeing's approach towards the 'Make in India' policy?

Boeing is committed to 'Make in India'. In fact, we have been 'making in India' with our partners for two decades, but are scaling this up with PM Narendra Modi's focus on manufacturing. 'Make in India' has wide prospects. It will give opportunities to become more competitive. We can leverage India's capabilities in engineering. We have been manufacturing, in partnership with the TAL factory in Nagpur, composite floor beams for the Boeing 787-9, which is a game-changing technology. We have also opened a new line to manufacture sections of Chinook Heavy Lift Helicopters with our partner, Dynamatic Technologies, following the launch of `Make in India. Earlier, the Heavy Lift Helicopter contract was finalised with the Ministry of Defence. We are now looking to the government to tweak its offset policy so that true benefits (of Make in India) can be achieved.

What are these changes you want to see in the offset policy?

We have already shared our concerns with the government. There is rising optimism since much has been done to generate positive sentiment. 'Make in India' is designed to catalyse manufacturing, much like India's defence offset policy, which is also meant to facilitate the development of an indigenous defence industrial base.

Boeing understands the motivation for the policy and has submitted plans to meet these requirements. However, we believe some aspects of the current offset regime actually precludes India from fully realising benefits of the obligations Boeing and other companies

have incurred. For example, a period of performance for discharging the obligations, which results in Indian companies working on low-value, low-complexity activities. The period of performance for discharging obligations is 5-7 years and for high-technology this is not sufficient, you need a longer period. The inability of original equipment manufacturers (OEMs) to modify the content of proposed offset work packages or identify Indian offset partners based on performance is another concern because it prevents OEM Tier 1 suppliers from being fully included in discharging offset obligations. Also the current *Services in Abeyance* order prevents OEMs from accessing Indian IT and engineering capabilities for offsets, thereby hindering capacity building for highly engineered product manufacturing at their Indian offset partners.

If the offset policy is tweaked slightly, this can better serve the sector.

Please give an overview of Boeing's approach to partnership in India

Boeing has so far taken a non-equity route to partner the Indian industry, but we are also evaluating equity partnership opportunities. Boeing has been working with aerospace suppliers in India for over two decades in manufacturing, IT and engineering services, and has invested considerably in supplier development, training, tooling, and quality systems at these companies. Today, we have over 18 suppliers with world-class capabilities in aerospace manufacturing providing parts and assemblies covering commodities such as aerostructures, wire harness, composites, forgings, avionics mission systems, and ground support equipment. Since 2008, Boeing's engagement with suppliers has in-creased substantially for commercial and defence aircraft such as the 777, 787, P-8, F/A-18, F-15, and CH-47 Chinook. Boeing, in partnership with TAL (a Tata enterprise), has set up a state-of-the-art factory in Nagpur where composite floorbeams for Boeing 787-9, one of the most advanced aircraft in the world, are being produced. This is the first factory of its kind in India and is indicative of the complex manufacturing capabilities that Indian companies are developing.

Boeing estimates a demand for more than 1,600 new civil aircraft in India over the next 20 years. What would be Boeing's share?

We want more than our fair share. If you look at this market, we have slightly more than 50 percent share; we do pretty well on the twin-aisle segment where we have disproportionate share of the market. But the single aisle segment is very competitive; we have very strong competition and would want to out-compete them. We have a fantastic product to improve upon, the 737 NG. Overall, our aspiration is to get more than the fair share of the commercial aerospace market in India. And we are very confident given the proven economics of our products!

Please give your views on an ecosystem for Indian aviation industry

Aerospace manufacturing is complex and requires a huge ecosystem of high technology research and development, advanced manufacturing processes, highly skilled people, services capability and much more. In India, first we need to have sophisticated engineering and software capability to support the manufacturing process. Then there is the need for frontline factory workers, who are able to do complex aerospace manufacturing. Today, there is a huge supply-demand gap for trained factory-line workers and engineers. So skilling a workforce is an imperative. We are working with National Skill Development Corporation (NSDC) to address this gap and to develop vocationally trained frontline workers in advanced manufacturing. The partnership between Boeing, NSDC and Nettur Technical Training Foundation has already produced its first batch, which has been fully absorbed by one of our very own suppliers.

What are the immediate opportunities for Boeing in India?

In India, Boeing sees opportunities for attack helicopters, heavy-lift helicopters, unmanned systems and services and support. As the modernisation of India's armed forces progresses with acquisition of new platforms and upgradation of existing ones, a major focus is on ensuring operational readiness through a product's lifecycle by means of affordable support and services. With deliveries of 10 C-17 Globemaster III heavy airlifters to the air force and six P-8I long-range maritime surveillance and anti-submarine aircraft, Boeing is ramping up support services in India.

How does Boeing plan to exploit the technologies developed in the joint Aerospace Network Research Consortium with Wipro, HCL and the Indian Institute of Science?

This is very high-end network consortium. If you look at the evolution of wireless networking technologies on board, it has all kinds of possibilities. For example, if you could have low energy wireless systems on board, then you could have telemetry on real time conditions of different equipment on the aircraft to monitor that and it changes the game completely.

I know this sounds a bit futuristic but if you look at the aviation system, this has evolved from fly by rope to fly by wire to fly by light. So we are at the cutting edge of that sort of evolution with our consortium partners. It's futuristic technology and will take some time to come by but between now and then, we are doing some interesting innovations which we will look to put into the next generation platforms as well.

What are Boeing's objectives on its partnership with IIT-Mumbai for the National Centre for Aerospace Innovation & Research (NCAIR)?

It goes all the way from training our suppliers for getting NADCAP (National Aerospace and Defence Contractors Accreditation Programme accreditation to really helping them solve real time problems. The ultimate goal is to create a globally competitive supply chain.

What is Boeing's long-term strategy in India?

Our business strategy has a twin focus. The first is to provide a winning platform to the country's commercial aviation and military customers with state-of-the-art, reliable and fuel-efficient products, supported by world-class services. The second is to create an ecosystem for aerospace manufacturing in India through partnerships with local companies, government enterprises and academia.

Our goal is to bring the best of Boeing to India and build our proven state-of-the-art commercial platforms. We want to harness the engineering capabilities on offer. Going forward, you will see Boeing accelerate its presence in India and partner Indian companies, well realising 'Make in India' for the aerospace and aviation sector.

India's Eagle Eyes

The Embraer Airborne Early Warning

Brazilian aircraft manufacturer Embraer is reportedly in discussions with India's Centre for Airborne Systems (CABS), a Defence Research and Development Organisation (DRDO) research centre, for joint development and export to South American countries of the Indian AEW&C (Airborne Early Warning & Control) system integrated with Embraer's EMB-145 aircraft. India had ordered three EMB-145 aircraft from Embraer in 2008, as a platform for mounting DRDO's indigenously developed AEW&C suite for the Indian Air Force. The aircraft is likely to be handed over to the IAF for operational use in 2015. The Indian Cabinet Committee on Security (CCS) had approved the programme in 2004 at a project cost of $396 million to develop two operational systems and one engineering prototype. DRDO has, in principle, approval to develop five more systems on the EMB-145 platform. The original date for completion of the project was October 2013, which was revised to March 2014, but now seems to have been delayed further and will probably be inducted in the IAF sometime in 2015.

The system mainly consists of primary surveillance radar, an Identification Friend or Foe (IFF) radar, Electronic Support Measures (ESM) equipment and communication systems. The aircraft's radar warning receiver is integrated with the ESM system and in addition has a Missile Approach Warning System (MAWS) and Counter Measures Dispensing System (CMDS) as part of the self protection suite. Embraer has made many modifications to its aircraft, which was originally a regional jet. The airframe has been structurally strengthened to take on the load of the radar and modified to house mission systems, an air-to-air refuelling probe, SATCOM antenna and improved cooling structures. Embraer handed over the first fully modified aircraft to CABS in August 2012. DRDO has developed the flat planar antenna which is installed on the fuselage. It is a dual side linear-shape active electronically steered array (AESA) radar similar to the Chinese KJ-200 and Swedish Ericsson Erieye.

This shape of the antenna cannot provide coverage in front over the nose, but

& Control Aircraft

The first EMB-145 AEW&C aircraft seen at Aero India 2013 (photo: Angad Singh)

will provide 120° coverage on either side of the aircraft. The 120° limitation is a physical constraint, being the maximum Field of View (FoV) that a planar phased array antenna can provide. This limitation exists all planar arrays, such as the KJ-200 and Erieye. The Pakistan Air Force operates the Swedish Erieye but in addition has purchased the Chinese ZDK-03 radar that provides 360-degree coverage when mounted on a rotodome on the Y-8 turboprop platform (a Chinese copy of the Russian An-12).

The EMB-145 cabin has been modified to install five operator work stations, additional fuselage fuel tanks and five crew rest areas. The communication links consist of C-band data link, Ku-band SATCOM and five V/UHF frequencies. The V/UHF frequencies enable the onboard fighter controllers to transmit voice and data to aircraft under control. The aircraft communication system is networked to the air defence command and control radar stations on the ground through direct digital data link and through satellite as back up. Another modification is the additional auxiliary power unit to meet power requirements of the radar and mission systems. The AEW system has a maximum crew of 12 and Indian officials have claimed that it can fly nonstop for 10-12 hours with mid air refueling. It has not yet been revealed what is the time on station likely to be but considering that this is a regional jet derivative, the time on station at a distance of about one hour flying time from home base, will be approximately four hours. Thus, to maintain the EMB-145 on station for longer duration will require adequate tanker support. The EMB-145 AEW&C, with a detection range of 300 km for fighter-sized targets, will supplement the cover of the full size longer range AWACS and will also be useful as gap-filler radar.

The induction of this system in the IAF will be a big achievement for DRDO but the real test will be to overcome ground clutter problems. In airborne radar the signal return from ground echoes is stronger than the target signal and the radar system must be designed to overcome this limitation. The Americans overcame these problems in their first AWACS (the Boeing E-3A in the 1970s) by developing Pulse Doppler radar technology. Since this technology is quite dated, DRDO should not have any problem in this field. The major technological breakthrough DRDO has achieved is in the indigenously developed AESA technology for the radar. AESA technology is the current state of the art benchmark for radars and DRDO's success in this field is certainly a quantum jump from the PESA (Passive Electronically Scanned Array) technology used in DRDO's Rajendra radar for Akash missile system. DRDO has been trying to develop AESA technology since the 1990s but the breakthrough was achieved when they applied for a patent for the homegrown T/R modules (Transmit/Receive modules) a few years ago.

The EMB-145 AEW will certainly supplement IAF's full size AWACS radar operations. DRDO seems to have mastered the technology for airborne radar; it must now concentrate on delivery schedules to meet customer requirements. Project delays have been a major drawback and DRDO needs to be held accountable for their failure in meeting schedules. Another point to note is the requirement of transport aircraft platforms for which huge amounts have to be paid to foreign vendors. India has a big requirement of transport aircraft in the civil and military sector. Instead of paying large sums abroad we need to consider 100% FDI in this field to produce them in India. In this way at least the nation will receive some benefits of the funding spent on platforms for AWACS/AEW for other roles "made in India."

Gp Capt Ravinder Singh Chhatwal (retd.)
Senior Fellow, CAPS

First World War Centenary Partnership

Dassault Aviation supports renovation of the Verdun Memorial

General Elrick Irastorza Chairman of the Board of Directors of the First World War Centenary Partnership, and Eric Trappier, Chairman and CEO of Dassault Aviation, signed a sponsorship agreement at the Invalides building in Paris on 16 December 2014. The ceremony was attended by Jean-Marc Todeschini, French Minister of State for Veterans and Remembrance, attached to the Ministry of Defence.

According to the terms of this agreement, Dassault Aviation will fund the renovation of the Verdun Memorial. It will also deposit with this memorial museum an Éclair propeller from a Spad VII pursuit plane. This propeller was the first aeronautical design by Marcel Dassault to enter production. In addition to the Spad, it was also used on the Caudron, Nieuport and Farman airplanes that participated in the first large-scale aerial battle in history, in the skies over Verdun in 1916. The Éclair would also mark the start of the aviation career of Marcel Bloch, who would go on to design both civil and military airplanes between the two world wars. At the end of the Second World War, returning to France after being deported, Marcel Bloch would change his name to Marcel Dassault. This sponsorship agreement spotlights the roots of Dassault Aviation, the last major family-owned aerospace company in the world, still owned by its founder's family and bearing his name. It honours Marcel Dassault's contribution to the allied effort in the First World War, and also pays tribute to the memory of the generation that sacrificed their lives to defend their nation.

With over 8,000 military and civil aircraft delivered to 83 countries over the last 60 years, logging some 28 million hours in flight, Dassault Aviation has built up expertise recognised worldwide in the design, development, sale and support of all types of aircraft, ranging from the Rafale fighter to the high-end Falcon family of business jets and military drones. Dassault Aviation posted sales of 4.59 billion Euros in 2013, and has nearly 11,600 employees.

The Verdun Memorial (photo: Wolfgang Staudt)

BAE Hawk — from Red Arrows to future IAF Aces

Dramatic air-to-air shot of the Red Arrows in transit back to the UK after a display in the Netherlands (photo: SAC Adam Fletcher/UK MoD)

2014 was a memorable season for one of the world's most famous aerobatics display teams, the Royal Air Force's Red Arrows.

It was the team's 50th anniversary and for much of that time they have flown the BAE Systems Hawk jet trainer aircraft, an updated version of which could soon be used by the Indian Air Force's display team – the Surya Kirans.

For Flight Lieutenant Mike Child it has been particularly memorable with last season being his third and final with the Red Arrows. "It has been an amazing year," explains the pilot known as 'Red 9,' "and a great way for me to sign off after three years with the team.

"There have been so many memories which I will take from my time as Red Arrow, but I think the one which will live with me forever was displaying at the opening ceremony of the 2012 Olympic Games in London. "We've been to the Middle East, Russia, and all over Europe in the past three years; it has been an unbelievable experience."

The aircraft which took him there was the BAE Systems Hawk. The latest version is also used by the RAF to train its future fighter pilots but earlier variants of the Hawk have been used by the Reds since 1979.

The Hindustan Aeronautics Limited (HAL)-built Hawk advanced jet trainer is also used by the Indian Air Force for its frontline pilot training and is understood to be lined up for use by the Surya Kirans, the IAF's own aerobatic display team. Flt Lt Child is one of six members of this season's Red Arrows who learned to fly in a Hawk before going on to train pilots on it.

He says: "The Hawk is a real pilot's aircraft because you know whatever you put into it, you get a physical reaction from the aircraft. "The analogy I always give is that is Typhoon is an Aston Martin, big and powerful, the Hawk is like a Lotus Elise, quick and nimble, which is exactly what you want for aerobatic displays. "You want a stable platform when you are flying in close formation and an aircraft which is reliable, and Hawk gives you both of those in abundance."

A product of defence firm BAE Systems, which licences HAL to manufacture the Indian version, nearly 1,000 Hawks have been sold to18 air forces across the world.

In 2004, India bought 66 Hawks and ordered a further 57 in 2010 to train its pilots of the future. Flt Lt Child will now return to frontline duty with the RAF flying its Eurofighter Typhoon fighter jet, one of the world's leading multi-role fighter jets capable of switching seamlessly between air-to-air and air-to-surface combat. He adds: "I am looking forward to getting back to flying Typhoon, which is another phenomenal aircraft. "But, my time with the Red Arrows has been unforgettable; the affection which the team is held in by the British public has to be experienced to believe. "It is the team rather than the pilots as individuals that people connect with, and the aircraft have a huge role to play in that."

Courtesy: BAE Systems

Indian Air Force BAE Hawk 132 taking off at Yelahanka AFS (photo: Angad Singh)

Make in India is Right !

Extracts from the talk given by Mr Lars-Olof Lindgren, Chairman & Managing Director, Saab India Technologies, at the 'Vibrant Gujarat' Summit during mid-January 2015

My initial association with Gujarat was as the Ambassador of Sweden when the Swedish Chamber of Commerce and the Government of Gujarat signed a MoU in the presence of Mr Narendra Modi when we were pleased to commit on co-operation in research and development, including in the agro business.

I stand here today representing a Swedish Defence Company, Saab, which I believe has important experiences to share with the world on how a small country can put together and sustain a defence industry which is at the leading edge of technology and is globally competitive. We believe this road map can be shared with India and more so with the entrepreneurial spirit of Gujarat, which can leapfrog to frontline defence production with Swedish technology collaboration.

At the core of India's development premise today is the government's strategy to 'Make In India', such programme based on realisation that rapid industrialisation is the only way for India to meet its great challenges including employment of 12 to 15 million people entering the labour market each year.

Make in India is right for the indigenous defence industry too, and the best way to rapidly build capability is through partnerships with those who have it. Make in India is also in line with the ambitions to create an indigenous Indian defence industry of global scale. The real challenge is to build domestic capability in defence without forgoing cutting edge systems, which process requires Indian companies to 'leapfrog' technologies so as to start designing, developing and producing state-of-the-art systems in the immediate future and not through long drawn out programmes, which of course is true as much for defence as it is for any area of manufacturing. It is a fact that when the defence industry procures cutting-edge technology through standard procurement processes they are actually receiving products which are already half way through their life cycle, at best. No doubt, "proven technology" is required and thus the product would had to have been in service for some time. Then, the procurement process takes a number of years so when the technology is ready to be transfered, it may not be that relevant anymore! Thus, to acquire futuristic technology rapidly one must be innovative and 'Make in India' is the right step to ensure that the products are cutting edge when introduced in the Indian armed forces.

The only way to build the necessary capacity to design, develop and produce products indigenously in an acceptable time frame, would be to team up with a foreign company which has already worked on cutting edge technologies.

But to build that capability is not as simple as it sounds. This would involve setting up production facilities, transfer of knowledge building capability in India, design and development of next generation systems, as well as exports.

Technology, in that sense, is a key to unlock doors and not a hall pass that will keep bringing in rewards.

India has the capacity to "absorb" such technologies when partnering with OEMs as it has the qualified manpower, and importantly, this will generate employment for millions of people.

The end result should be the creation of an industrial base that will ensure that India does not need to look beyond its borders for its future technology requirements.

India's drive to develop indigenous defence capability requires partners with state-of-the-art technology that can be transferred to India with the support of their governments. Importantly, such companies should be driven by self-interest to carry out *real* transfer of technology and have genuine interest in joint development of new generations of products.

Having been in this country for some years, my experience is that India and Sweden could synergise their strengths: skilled Indian work force together with strong technology bias and engineers in combination with Swedish know-how form a perfect match. Saab could offer to build Next Generation products and solutions here in India, by Indians, for India and even for export. This will create thousands of high tech jobs in high end manufacturing as well as education in defence engineering through collaboration with IITs/ Indian Universities and Swedish Universities, including comprehensive exposure to Saab production concepts and way of working.

Sweden and Saab have a proven track record of sharing transfer of critical technologies. This is Transfer of Technology in the truest sense, and includes training, transfer of know-how, capability development and ensure development of the supply chain for cutting edge technology systems. We are not talking about how to use a screwdriver; we are talking about sharing critical technology so India could be self-reliant and build a state-of-the-art indigenous industry.

I believe that states like Gujarat, with its dynamic leadership, fertile soil for entrepreneurship and excellent infrastructure, can play a role in becoming the centre for India's defence manufactures.

The same conditions that apply to automobile companies when they chose to move to Gujarat, also apply to the defence industry: good infrastructure, reliable supply of energy, access to different kinds of land and sea environs to test its products and the ability to attract talent from across the country thanks to good standards of living. Gujarat has all those and a government that is committed to fast decisions.

Lars-Olof Lindgren at his New Delhi office (photo : Aungad Singh)

The foresight of successive leaders of Gujarat has made it a beacon for industry and progress and together we should create a strong defence industry in India of truly global standards.

IAI's new business-jet based maritime patrol aircraft

Israel Aerospace Industries (IAI) has introduced the new generation ELI-3360 Maritime Patrol Aircraft (MPA) based on a modified Bombardier Global 5000 business-jet platform. Designed by IAI's Elta Group to provide maritime domain situational awareness and maritime superiority, the new MPA provides the most sophisticated surveillance, reconnaissance and armament systems to be installed on a business-jet extant.

The system incorporates the advanced Elta EL/M-2022 Maritime Patrol Radar, an electro-optical sensor, the ELL-8385 ESM/ELINT system, and a comprehensive communications suite comprising radios, broadband SATCOM and data-links as well as advanced electronic warfare (EW) and self-protection suite. The integrated multi-mission command and control suite includes multi-purpose operator workstations and a weapon and stores management system which controls the under-wing weapons that may include torpedoes and anti-ship missiles for anti-submarine warfare (ASW) and anti surface warfare (ASuW) as well as dispensable Search and Rescue (SAR) stores.

IAI's new generation ELI-3360 Maritime Patrol Aircraft

The new generation ELI-3360 joins IAI's series of Special Mission Aircraft (SMA), and is based on IAI's 30 years of experience in supplying advanced maritime sensors and integrated systems to operators worldwide. IAI's line of business-jet SMA includes the operationally-proven Gulfstream G550 Conformal Airborne Early Warning (CAEW), and the G-V Signal Intelligence Aircraft (SEMA) - the world's first business-jet based mission aircraft.

"IAI provides leading-edge airborne, maritime and land-based solutions for persistent maritime reconnaissance and surveillance," said Nisim Hadas, IAI Executive VP and Elta President. "This allows our customers a choice of the right combination of ISR assets to meet their operational needs. The new business jet-based MPA, in concert with UAS and shore-based systems will provide unmatched maritime domain superiority for the benefit of our customers".

VAYU Interview with Nalin Jain, President and CEO, South Asia, GE Transportation and Aviation

VAYU : Under the new BJP-led government, India has taken on a very different defence posture not to mention a renewed commitment on indigenous production. What challenges and opportunities do you foresee?

NJ : The new government is taking steps in the right direction and 'Make In India' could become a great success story. GE has a huge opportunity from the defence and civil aviation standpoint. India can only realise its dream of becoming a credible aerospace player first by relying on the large domestic modernisation demand and then on maturity, pushing growth of exports.

There is an urgent need to develop the domestic market so as to achieve economies of scale. Manufacturers especially in the aerospace sector, are looking for predictable market dynamics leading to certainty and clarity on the procurement cycle, so presenting a complete business case.

That there is a positive change is evident - for instance DIPP which is acting as a catalyst to ensure that respective ministries are moving fast and getting results.

India certainly has the capability in the form of HAL while the LCA programme is something we should be proud of. India, however, needs to overcome significant competitive disadvantages such as non-availability of skilled aerospace labour, the high cost of power, high cost of capital, lack of scale, infrastructural bottlenecks and lack of core technology which impacts on viability of aerospace manufacturing. As the world's largest defence and aerospace importer, India does offer significant opportunities to global aerospace companies combined with some cost advantages, which can be realised over the long term. For successful manufacturing in the aerospace sector, Indian industry needs to work on multiple fronts viz. develop a strong supplier eco-system, innovate and develop new technologies, and acquire expertise by partnering with global companies.

As part of our localisation effort, GE has been supporting our key global suppliers to set up manufacturing in India. Over 100 parts are already being locally manufactured by suppliers. GE is supporting Indian MSMEs with capability building so as to become GE suppliers.

VAYU : Related to the 'Make in India' theme, GE's new manufacturing campus in Pune is expected to be operational shortly. While it is understood that this facility will cater to a variety of GE activities, what aerospace and defence manufacturing, if any, is to be conducted here?

NJ : GE is manufacturing several components for the global supply chain at its Multi-Modal Facility (MMF) in Pune. GE's Pune MMF is a large facility to source material for the GE aviation supply chain as well and looks at local opportunities to manufacture, including a significant amount for aviation. GE has invested $200million in the MMF, which is our largest manufacturing facility outside the USA, catering to domestic needs as well as the international market.

This state-of-the-art manufacturing unit of GE has the capability to train people on multiple-platforms of different scale, thus developing highly skilled workforce and achieving greater output.

VAYU : The IAF recently received its first production Tejas LCA, while the naval prototype made a successful trial at the SBTF in Goa in December 2014. GE's F404 is integral to the LCA programme, and the F414 is expected to play a role in the future LCA Mk.II as well. Could you give an overview of GE's involvement with the LCA Mk.I and Mk.II?

NJ : GE has a strong presence in the Indian aviation sector, which is among the fastest growing aviation markets globally. GE's military systems and intelligent platforms are equipping militaries with highly evolved solutions needed to improve reliability and enhance operational performance.

The Indian government has decided on upgrading of the LCA Mk1 and the Aeronautical Development Agency (ADA) is going ahead with LCA MkII for which the GE F414-INS6 engine has been selected. With transfer of technology and productionisation of the F414-INS6 expected to happen in the near future, India has a unique opportunity to leverage economies of scale and commonality for using this robust engine for its future fighter jet programmes. The F414-INS6 is currently on schedule in development and testing.

India should be proud of its success in the LCA. Building such capabilities takes years to develop fully; it is a learning curve which every country must go through.

VAYU : The Indian Navy has standardised GE LM2500 gas turbines for marine propulsion. In addition, there is a growing number of GE technology engines in service across the Indian armed forces, with CFM56s on IAF BBJs and Navy P-8Is, F404s on the aforementioned LCA and T700s on the soon-to-be contracted Sikorsky S-70B naval helicopters. How is this wide range of products supported and is GE exploring new approaches to providing support as the number of engines in service grows?

NJ : GE Aviation is a world-leading provider of jet and turboprop engines, components and integrated systems for commercial, military, business and general aviation aircraft. We also have a significant

presence in supplying engines for marine applications.

Today, GE is supporting India's defence modernisation through reliable and proven solutions for indigenous aircraft programmes. GE's military engines provide the power and reliability for many military applications.

GE's LM2500 marine gas turbines are used for propulsion requirements at local shipyards. GE has also supported HAL in the establishment of a dedicated test cell in Bangalore for the assembly, inspection and testing for LM2500s. HAL has already supplied seven LM2500 Marine Gas Turbines to Mazagon Docks Ltd and four LM2500 Gas Turbines to Cochin Shipyard Ltd. These LM2500 GT propulsion modules are for the Indian Navy's P-17 Stealth Frigates programme and the P-71 Indigenous Aircraft Carrier Programme.

GE contributes significantly in the P-8I programme, providing capabilities to meet India's maritime patrol and anti-submarine warfare requirements. CFM [a 50/50 joint venture between GE and Snecma (Safran Group)] has its CFM56 engines on the P-8I. GE also provides the Mission & Stores Management Systems on the P-8I.

The helicopter market is a very exciting space for us. GE is investing in technologies which are fuel efficient, reliable and optimise the total cost of ownership. Apache AH-64 attack helicopters with fuel efficient T700-GE-701D engines powers the machine to operate with more equipment, than earlier versions.

Dowty Propellers,a GE company and a part of GE Aviation business, is a global leader in propeller systems. These propellers are used in the C-130J fleet that we expect will grow in India.

GE's global Maintenance, Repair and Overhaul (MRO) network helps customers keep their aircraft engines operating at peak performance, no matter where in the world.

VAYU : GE's John F Welch Technology Centre in Bangalore has been in operation for over a decade now. How has work at this facility tied with GE's activities both in India and overseas?

NJ : As you mention GE has one of the largest research facilities in India located at Bengaluru. The John F. Welch Technology Center (JFWTC) employs over 5000 advanced researchers who provide inputs to global teams to develop advanced technology products. The team at JFWTC is playing a significant role in design and certification of next generation aircraft engines (LEAP, GE Passport20, F414-INS6 and GE9X). Our team has been pivotal in advancing state of the art technologies (Production composite advancement for GEnx/LEAP/GE9X, TAPS Combustor for GEnx/LEAP) that help differentiate the new products in the market.

VAYU : What are the main focus areas for GE at this year's Aero India?

NJ : The LCA has received its IOC 2, which is proud moment for India and all stakeholders in the programme including HAL, ADA as well as GE. We expect that LCA will receive a fair bit of attention at Aero India 2015.

Our team will represent some of the leading technologies in aviation space, which, we feel, is of great interest to India's defence community.

The GE Booth is at Hall E 3.9 at Aero India 2015.

The GE F404 powers the HAL Tejas LCA Mk.I, while the F414 has been selected for the LCA Mk.II

VAYU Interview with BEL CMD, S K Sharma

VAYU : What's your views on participation at Aero India 2015, and what is BEL showcasing here ?

SKS : Aero India 2015 is one of the major international exhibitions and a platform for showcasing capabilities in products and services for the Defence Aerospace industry. Aero India 2015 is a unique opportunity to promote products and expertise, expand international network and demonstrate the capacity for innovation. Specialists, policy makers and buyers from all over the world will be present to update themselves on the latest in the industry.

BEL will showcase its key products and systems in the following major areas of its business: Electronic Warfare & Avionics, Radars, Electro Optics, Fire Control Systems, Shelters, Sonars, C4I Systems, Simulators, Communication equipment like Software Defined Radios, HF Radios & Radio Relays, and Encryptors including Terminal End Secrecy Device (TESD), IP Encryptor and Link Encryptor for Versatile Environment (LIVE).

VAYU : What opportunities such as 'Make in India' and the Indian government's decision on increase in FDI to 49%, delicensing of military MRO, mean for the company?

SKS : It is expected that increase in FDI would bring in core and critical technologies in defence, which will require large investment and resources in manufacturing and R&D capability. To absorb and further develop these technologies, we must have a commensurate ecosystem, manufacturing infrastructure, R&D and manpower to take advantage of larger FDI. This will also require conducive government policies and environment for defence export, protection if IP and other business interests of Indian and foreign firms.

With the present government's firm resolve to push for 'Make in India' programmes, global OEMs would be looking for co-development and co-production arrangements with Indian industry, leveraging the skilled manpower and infrastructure available locally to address the Defence market. This will help the organisations like BEL and others who have excellent manufacturing infrastructure, R&D capability and skilled manpower.

VAYU : What are the performance highlights of BEL in 2013-14? And what's the growth the company is tracking in the current financial year?

SKS : The company achieved a turnover of Rs.6,174 crores in 2013-14 and the PAT grew by 15.2% in comparison to the previous year. An all-time high growth of 28% was achieved in exports by registering sales turnover of US$ 42 million. For the first time, the company exported state-of-the-art Sonar systems and also successfully commenced manufacturing of aircraft cable looms for Pilatus, Switzerland.

The major orders executed during 2013-14 for our defence and civilian customers include Akash Missile Systems (Army and Air Force), Passive Night Vision Devices (PNVDs), Low Level Light Weight Radars, Missile Warning System (MWS), Hull Mounted Sonars, Shipborne EW systems, Central Acquisition Radars, Coastal Surveillance System and Electronic Voting Machine.

In the current financial year BEL expects top-line growth of 8 to 10% with several new orders in the pipeline.

VAYU : What are the operational highlights during 2014-15 thus far ?

SKS : The company has registered a turnover of around Rs.4,000 crores up to the end of the third quarter and will be able to achieve the planned turnover for the year. Major deliveries executed so far are for Passive Night Vision Devices (PNVD), Schilka Upgrade, 3D-Tactical Control Radar (3D-TCR), Low Level Light Weight Radar (LLLWR), Missile Approach Warning System, Laser Range Finder, Akash Weapon System, Central Acquisition Radar (CAR), Ellora Mk II, Sanket 'S' and HUMSA 3G.

Certainly, major highlights of the year include handing over of the first 3D Tactical Control Radar (3D-TCR), a state-of-the-art, medium-range air surveillance and tracking radar and an upgraded Schilka Air Defence System to the Indian Army.

VAYU : What is BEL's order book position?

SKS : As on 1 December 2014, the order book of the Company is around Rs.22,500 crores. This comprises major programmes such as Akash Missile Systems for the Air

Army version 3-D CAR

Software Defined Radio

Force and Army, Battlefield Surveillance Systems, Command Information Decision Support Systems, Fire Control Systems, Passive Night Vision Devices and some of the new generation Radars, Sonars and Electronic Warfare Systems.

VAYU : What about BEL's latest joint venture with Thales?

SKS : Subsequent to approval from the Foreign Investment Promotion Board (FIPB) and the Ministry of Defence (MoD), a Joint Venture Company (JVC) between BEL and Thales, France, was incorporated in Bangalore on August 28, 2014, and named as 'BEL-Thales Systems Limited'. BEL and Thales have share ratio of 74% and 26% respectively. The JVC has obtained all statutory approvals and licenses for commencement of business and is operational.

Currently, the JVC is focusing on Air Traffic Management Radars for both civilian and defence applications. The JVC is also exploring the possibility of developing Passive and Multi Static Passive Surveillance Radar for futuristic Air Traffic Surveillance and Management, Multi Target Tracking Radars for Naval Fire Control application and Geo Radars for ground penetrating, slope detection and early warning high wall failures in open cast coal mine applications.

VAYU : Please inform us of the company's association with TCOM USA to co-operate on aerostat surveillance and communication systems, the progress made so far and the roadmap you see going forward ?

SKS : BEL entered into a MoU with TCOM, USA, in 2013, for offering cost effective, world-class aerostat based surveillance and communication systems to the Indian Defence Services, Security Services and Law Enforcement Agencies to augment their surveillance capabilities. This MoU is a stepping stone for BEL to enter into the manufacturing and supplying of aerostat based surveillance and communication systems. With the co-operation of TCOM, BEL will also be establishing a facility for carrying out Depot level repair and maintenance of aerostat systems.

BEL, in co-operation with TCOM, has submitted technical proposals against many RFIs/EOIs to various prospective Indian customers. The payloads include Radar, ELINT, COMINT, ESM & ECM and Electro-Optic Systems.

VAYU : Could you also elaborate on your expanding partnership with Boeing concerning manufacture of F/A-18 Super Hornet sub-assemblies?

SKS : Besides supply of various sub-assemblies for the F/A-18, BEL also provides Boeing the Identification Friend or Foe (IFF) Interrogators and Data Link II Communications systems for the eight P-8I Maritime Surveillance Aircraft supplied to the Indian Navy. BEL is a partner with Boeing at the 'Analysis and Experimentation Centre' in Bangalore, opened in 2009.

BEL and Boeing, USA are also working on expanding their business partnership through different Aircraft and Helicopter programmes of the Government of India. Fulfillment of offset obligations and other direct exports are being explored.

VAYU : Could you share some details on your agreement with Elbit Systems Electro-optics-Elop Ltd, Israel, for joint production of Compact Multi-Purpose Advance Stabilisation System (CoMPASS) for Naval helicopter applications, as also the progress made so far?

SKS : BEL entered into a Technology Collaboration Agreement (TCA) with Elbit Systems Electro-optics-Elop Ltd (ELOP) in 2010 for manufacture of CoMPASS for the Advanced Light Helicopter (ALH) programme. As per the TCA, BEL has acquired the License, Know-How, Technical Information, Training, Technical Assistance to manufacture BEL's work share, perform final assembly / testing of the CoMPASS using ELOP's work share and to sell the CoMPASS to ELOP in case of ALH program and to sell the CoMPASS to end user only for future programmes, subject to Israeli Government approval. The technology transfer also enables BEL to provide D-level maintenance to customers. CoMPASS for ALH platform is currently under production.


Flight Level Radar

"For India, together with India"

VAYU Interview with Sergey Korotkov, Director General, RAC-MiG

VAYU : ***RAC-MiG is well known in India. What are current programmes MiG are implementing in India?***

SK: First of all, I would like to outline that for decades India has been, and will remain, our major foreign partner, and we will do our best to continue our collaboration in to the future.

MiG has been closely working with its Indian customers for over 50 years now. During this half-century we have come a long way from direct deliveries to the current system of industrial and technological cooperation, which has made it possible to provide Indian armed services with state-of-the-art aircraft.

RAC-MiG are presently conducting a number of projects in India, including supply of modern fighters, upgrade of various MiG aircraft operational here, and their comprehensive, full-scale maintenance.

VAYU : Talking about supplying fighters, we assume you mean MiG-29K/KUBs for the Navy? Could you kindly brief us on the programme?

MiG-29KUB of the Indian Navy's 303 Squadron

Indian Prime Minister Narendra Modi in cockpit of MiG-29KUB seen with Chief of Naval Staff Admiral Robin Dhowan onboard INS Vikramaditya

SK: MiG has scrupulously adhered to its obligations under this contract for supply of MiG-29K and MiG-29KUB fighters to the Indian Navy, confirmed by the very fact that MiG has fulfilled its plans for supply during 2014. It is also important to note that this is actually our second MiG-29K/KUB contract for the Navy, the first one entirely completed by 2011.

Our cooperation has gone well beyond straight forward supply of aircraft and equipment. Indian industries are involved in deliveries of high-tech systems for the MiG-29K/KUB family. Our test pilots have assisted their Indian counterparts in converting to these fighters and I would like to tell you that we are really impressed by the professionalism of Indian Navy pilots. Your pilots met the challenge of flying from the aircraft carrier INS Vikramaditya with courage and skill.

In 2015-2016 MiG will continue to fulfil its contractual obligations on MiG-29K/KUB deliveries.

VAYU : The new Indian government has declared that self-reliance in defence manufacturing is a priority. In what way will this influence MiG's export policy?

SK: For decades, Russia and its industries (including RAC-MiG), have attributed great deal of importance in our contributing to the development of Indian industries. In the early 1960s, our military-technical cooperation first started with the MiG-21 project, which type was licence-manufactured in India for decades. Much later, all MiG-27 attack aircraft of the IAF were also produced by HAL in India.

Indian industries are closely involved in the MiG-29UPG upgrade programme, where they have significant work share.

RAC-MiG has also achieved a real breakthrough in the conduct of the operational maintenance of our aircraft. We have precisely for this purpose planned to open an Indian training centre for pilots of MiG-29UPG fighters in 2015, while during 2016 we will open a domestic MiG service centre.

We are eager to expand our collaboration with India under the slogan "For India, together with India."

VAYU : Has the Russian MoD sought to acquire new MiG fighters?

SK: Yes, they have. MiG is currently implementing a number of contracts for the supply of fighters to branches of the Russian military. For instance, we have begun deliveries of MiG-29K/KUB ship-borne fighters to the Russian Navy.

Also, a year ago we signed a contract for supply of another batch of MiG-29SMT fighters for the Russian Air Force (RuAF). This is a relatively inexpensive aircraft with multi-role capabilities, which has already demonstrated excellent performance in operational service with the RuAF. Pilots of one RuAF regiment, operating MiG-29SMTs were winners of the 'Aviadarts' international contest in 2014.

We are also conducting preliminary talks with the Russian Air Force regarding supply of advanced MiG-35 fighters. This aircraft is being promoted for export as well.

Fighter production rates at RAC-MiG plants are being steadily increased, with production standing at 20 aircraft annually at present. Plans are to increase this to 30 aircraft per year, which increased volume will let us cover our obligations to the Russian MoD as well as our foreign customers.

Indian Defence Minister Manohar Parrikar with his Russian counterpart Sergey Shoigu, leading delegation level talks at South Block, during the latter's visit to New Delhi in January (MoD photo)

Sukhoi FGFA preliminary design complete, production "to be accelerated"

According to Russian media reports in early January, the preliminary design for the Sukhoi/HAL Fifth Generation Fighter Aircraft (FGFA) has been finalised. FGFA is the designation given to the India-specific export variant of the Sukhoi T-50 PAK FA fighter currently under development in Russia. The IAF plans to operate some 120 FGFA (down from an original 220), with production to commence in about 2020. The programme cost for India is estimated at over $25 billion, with the aircraft to be built domestically at HAL Nashik.

However, according to Andrey Marshankin, Regional Director of International Cooperation at UAC, the Indian Air Force is still keen for the FGFA to be a twin-seat aircraft instead of a single-seat fighter, as the PAK FA (T-50) is currently configured. It is not yet clear whether the twin-seat configuration is part of the preliminary design stage of the FGFA.

It had earlier been reported that the IAF would drop its twin-seat requirement given that development of such a major modification would drive up costs considerably — to the tune of $1 billion — as well as delay the programme. The PAK FA is well into its flight-testing campaign, and Russian officials believe that adding a second seat is not necessary given the aircraft's vastly improved capabilities over the current crop of 4/4+ generation fighters.

Later in January 2015, Russian Defence Minister Sergey Shoigu made a 3-day visit to New Delhi to re-affirm Russia's commitment to defence cooperation with India. He met with Indian Defence Minister Manohar Parrikar on 21 January, where it was reported that the two Minsters agreed to accelerate work on the FGFA programme. "We want to start using a new fighter much earlier than the originally designated period – 2024-2025," said Parrikar.

The first PAK FA prototype made its maiden flight almost exactly five years ago, taking to the air from Komsomolsk-on-Amur on 29 January 2010 with famed test pilot Sergei Bogdan at the controls. Five development aircraft have since joined the test campaign, and UAC officials have indicated that the first production aircraft will be delivered to the Russian Air Force next year, following which the T-50 will be given a formal military designation and begin to be made operational.

The second PAK FA prototype (T-50-2) during a flight display at the MAKS air show in 2011 (photo: Dmitry Zherdin)

OIS-AT launches hi-tech radars at Aero India 2015

Under the banner of 'Make in India, for the world,' OIS-AT is conducting the global launch of four advanced technology dual-use radar systems at Aero India 2015. Development and manufacture of these systems has been underway for a number of years, and each unit fulfils a unique user requirement.

A breakthrough for the Indian aerospace and defence sector, these advanced radar systems are designed, developed and manufactured entirely by OIS-AT. The four advanced surveillance radar systems leverage advanced technology developments that are under patent filings.

The radars are designed for domestic and global market requirements, and as the owner of the intellectual property rights (IPR), OIS-AT is accelerating its global sales initiatives by launching them at Aero India 2015.

Expressing his deep satisfaction on this launch, Sanjay Bhandari, Founder Chairman and Managing Director of the OIS Group of companies said, "OIS Advanced Technology has worked diligently over the past few years to create its own intellectual property to invest, design, develop and manufacture these advanced technology radars. It is with great pride that we at OIS-AT are launching these four advanced radar systems for global markets, in essence taking Indian intellectual property and manufactured product to advance our expanded vision of Taking Make in India to the World. I am sure this is just a beginning and we will continue to blaze new trails in manufacturing newer, more innovative products for India and world markets."

Bird Radar

Further commenting on these systems, Bhandari said, "We are now recognized as an advanced radar system house. Each of these radar systems is a combination of functionality and performance and is representative of a breakthrough in technology uniqueness, or its advanced technology availability outside traditional radar providers in the West."

Targeted at aviation safety for both military and civilian airports, OIS-AT's true '3D bird detection, tracking and monitoring and deterrence' radar system has an impressive deterrence option, using directed bio-acoustics (sound) and an eye-safe laser, both of which are automatically controlled by the radar system.

OIS-AT has designed, developed and manufactured another Indian industry first — a '3D multi-function, multi-mode UAV detection and tracking and air surveillance' radar system. This radar system can be automatically tuned for detecting UAVs or high-speed fighter aircraft and helicopters. Unlike most air surveillance radars, it includes a unique sense-and-avoid feature to identify UAVs that may be on a collision course, allowing the controller to take remedial action.

Another development that has broken technology barriers is OIS-AT's 'foliage penetration minefield, IED and dismount detection' radar system which can identify people with weapons and other assets hidden under foliage from a fixed wing aircraft or UAV installed with this radar. With product availability slated for year-end, this system can also detect mines and buried IEDs to help sanitise routes and discover minefields to protect friendly troops.

In addition to these radars, which are primarily used for air surveillance, OIS-AT has also designed an advanced 'portable ground surveillance' radar system for both military and homeland security applications.

OIS-AT has used a user-focused design philosophy, recognising that different customers have differing needs worldwide. OIS-AT's four radars are specifically designed to offer a combined 34 configuration options to provide the global user flexibility to pick the configuration that most suits the application, be it military or non-military. To be marketed globally, these radars are backed by warranty and service that are designed to provide reliable and effective operation.


MRRWP

Aircraft armouring

MKU: Making India proud

MKU Pvt Ltd, a leading manufacturer of ballistic protection solutions for personnel and land-air-sea platforms, is participating in Aero India 2015. MKU is exhibiting at Hall C, Booth No. 2.14.

MKU is showcasing the 'Modulare Schutz Technik': the German engineered, revolutionary attachment systems enable the armour kits to be easily deployed on the aircraft, without necessitating any modification in the structure of the platform. This unique process and technology keeps the air worthiness intact. The patented and battle proven attachment systems allow the armour kits to be easily removed for alternate missions requiring full payload capacity like rescue and transport.

Complementing the 'Modulare Schutz Technik,' is the 6th generation armour protection technology developed by MKU. It uses advanced materials, and specialised manufacturing processes, to reduce the weight and thickness of armour solutions by almost 40%, resulting in operational benefits like increased useful payload and endurance. Also on display at the exhibition is a range of body armour and night vision devices for aircraft pilots.

MKU was setup in 1985, in Kanpur, India and today has expanded its global customer footprint in over 100 countries. In 2008 it acquired a company near Hamburg, Germany and has named it MKU GmbH. MKU has the experience of providing armour solutions for over 200+ aircraft, 500+ naval vessels and 1500+ land vehicles with customers in Europe, South America and Asia.

It has been a registered supplier to NATO since 1993 and has manufacturing facilities in India and Germany. MKU products are used and trusted by more than 230 forces in over 100 countries worldwide including the UN. Its state-of-the-art manufacturing facilities are certified according to AS 9100 C and ISO 14001 for environmental standards.

Helipilot vest with communication helmet

Sikorsky at Aero India

After being selected in December 2014 to meet the Indian Navy's Multi-Role Helicopter (MRH) requirement with the S-70B, Sikorsky is understandably optimistic about the Indian market. With a 'foot in the door' with the Seahawk, Sikorsky could very well see a larger order in the future if the Navy elects to take advantage of single-type fleet commonality in logistics, maintenance and training. The burgeoning civil helicopter market, particularly for the offshore oil and gas sector, is further cause for enthusiasm. It's no surprise then, that Sikorsky is an enthusiastic participant at Aero India 2015.

"I think Aero India provides a great platform for the global aerospace companies to come to India and showcase their products and also highlight to the decision makers in India what is available and choose those products that suit the country's security requirements. Hope this year's Aero India is successful for both the aerospace & defence companies as well as for the Indian Government.

Air Vice Marshal (Retd.) Arvind Walia, Regional Executive, India & South Asia, Sikorsky

There are three major aspects of Sikorsky that we would like to highlight through this year's Aero India exhibition. First, Sikorsky's long (over 90 year) history of making some of the world's best known military and commercial helicopters and associated technologies. Second, Sikorsky's global partnerships, such as the JV with Tata Group in India where we bring not just the latest technology but also best practices of the manufacturing world and third is Sikorsky's belief in doing business ethically and competitively across the globe", stated Air Vice Marshal (Retd.) Arvind Walia, Regional Executive, India & South Asia, Sikorsky.

The S-70B Seahawk is a versatile proven, off-the-shelf, cost-effective, multi-mission maritime system. It is designed to operate from frigates, destroyers, cruisers and aircraft carriers and can perform search and rescue, medical evacuation, surveillance, vertical replenishment and utility missions. The weapons management system has a flexible open architecture capable of integrating indigenous weapons and mission equipment and the aircraft fits the unique needs of the Indian Navy.

S-70B

S-92

The S-92 provides comfort, safety and mission-flexibility required by demanding operators for offshore oil transport, executive transport, SAR, airline and utility operations. The S-92 is the most advanced aircraft in Sikorsky's civil product line, certified to the most stringent U.S. and European safety requirements. The state-of the art technology includes active vibration control, composite blades and a list of safety features. The S-92 helicopter programme has a strong focus on reliability improvement – in 2010 Sikorsky certified 20 projects to expand mission capability and increase availability. The helicopters perform search and rescue (SAR) missions as well as a variety of transportation missions for VIPs including Heads of State, offshore oil and gas crews, utility and airline passengers. The worldwide fleet of 151 S-92 helicopters has accumulated more than 365,000 flight hours since deliveries began in 2004.

Russian Helicopters leads industry modernisation; getter stronger in South Asia

Russian Helicopters is continuing to modernise its production capacity under the Federal Targeted Programme Developing the Military Industrial Complex in the Russian Federation 2011-2020. In the latest phase of modernisation, the Ulan-Ude Aviation Plant launched a programme to re-tool and upgrade its production facilities. The first stage involves modernising and expanding production of protective coatings. "Project development on this started in 2013, due to the need to upgrade the technical equipment at the plant in order to increase efficiency and to ensure the products made were of the highest possible quality," Russian Helicopters CEO Alexander Mikheev said. "This technological upgrade will see the plant equipped with the necessary technological resources to launch serial production of our new multirole Mi-171A2 helicopter."

Mi-171Sh

Launching protective coating production involves the comprehensive modernisation of key parts of the manufacturing process, such as chemical processing and the application of chemical, electro-chemical and paint coatings on helicopter components. Implementation of this project will involve re-tooling the plant's production base, purchasing and installing technological and auxiliary equipment, and carrying out design and survey work. This will optimise processes, reduce load flow, implement the latest technical control parameters and improve environmental safety levels. The modernisation programme has been underway at Ulan-Ude Aviation Plant for five years.

Russian Helicopters has stated that modernising production is a priority development area. The company started implementing this project in late 2008, and has invested significant resources in achieving this goal. Russian Helicopters' key projects in this area include establishing a specialised machine processing centre at the Kazan Helicopters helicopter factory, retooling the Reductor-PM component manufacturing facility in Perm, building a unique casting centre at the Progress Arsenyev Aviation Company in the Far East, as well as upgrading the technological resource base and opening new dynamic laboratory testing and anodising facilities at the Rosvertol helicopter facility at Rostov on Don.

Mi-17V-5

Meanwhile, Russian Helicopters is strengthening its market position in South Asia especially with the Mi-171E and Mi-17V-5. Theses are designed to carry personnel and cargo, and can fly a range of missions to supply and evacuate troops. The Mi-8/17-series helicopters are widely used across South Asia, and are often an indispensable means of transport and form the core of military helicopter fleets.

In October 2014 Russia completed deliveries of 63 Mi-17V-5 transport helicopters to the Afghan National Army under a Rosoboronexport contract. The Mi-17V-5 is produced by Kazan Helicopters, a Russian Helicopters company, and has repeatedly demonstrated its abilities in adverse climatic conditions in Afghanistan's mountain regions.

Earlier in 2014 another large Rosoboronexport contract was fulfilled with the delivery to China of 52 Mi-171E helicopters built by Ulan-Ude Aviation Plant, another Russian Helicopters company. The Mi-171E operates successfully in China, and is widely used in regions with challenging terrain and harsh climates to transport medical supplies, humanitarian aid and construction materials.

French AF orders 12 A330 MRTTs

12 Airbus A330 multi-role tanker transports (MRTTs) are to be procured by the *Armée de l'Air,* the type named *Phénix* (Phoenix) in French service. First delivery is expected in 2018, followed by the second in 2019, with the remainder following at a rate of one or two per year. The contract has been agreed between the French defence procurement agency the Direction *Générale de l'Armament* (DGA – General Directorate of Armament) and Airbus Defence and Space

and will cover the development and qualification of the specific French configuration as well as the associated support and training systems, such as spares, ground support equipment, training devices and five years of in-service support from the date of first delivery. The A330 MRTT will be powered by Rolls-Royce Trent 700 engines and equipped with a combination of the Airbus Refuelling Boom System and underwing hose-and-drogue refuelling pods. The aircraft could be in various configurations, including transportation for up to 271 passengers or as a medevac aircraft. The 12 A330 MRTTs will provide the French Air Force with a modern multi-role fleet to replace four older aircraft types, including 11 C-135FRs, three KC-135RGs, three A310s and two A340s.

Development order for Saab Gripen E

Saab has received a development order for the new generation Gripen E from the Swedish Defence Materiel Administration (FMV). The order is part of the Gripen E framework agreement from 2013 and is valued at SEK 385 million. "The work on Gripen E goes according to schedule and budget. The order is part of the high-tech development of the next generation Gripen system to Sweden", stated Ulf Nilsson, Head of Business Unit Gripen within Saab's business area Aeronautics. Gripen is unique in combining high technology and capabilities with cost efficiency. Gripen E has significant performance improvements, including a more powerful engine, longer range, more weapons, new AESA radar and more advanced avionics.

Typhoon to get AESA radar

Development of the Captor-E active electronically scanned array (AESA) radar for the Eurofighter Typhoon has finally been given the go-ahead. The new radar is being developed by Eurofighter GmbH and the Euroradar consortium comprising Selex ES (UK and Italy), Indra (Spain) and Airbus Defence and Space (Germany). Meanwhile, Royal Air Force Typhoons have carried out

the operational release of live Paveway IV weapons. Typhoon FGR4s of No 1 (F) Squadron from RAF Lossiemouth were involved in the mission to deliver the latest Typhoon capability upgrade, known as P1EB, which is predominantly a software upgrade to provide the Typhoon with improved air-to-ground capability. It incorporates enhancements to the Litening III Laser Designator Pod (LDP), as well as integration of both the Helmet Equipment Assembly (HEA – the helmet mounted sight) and Paveway IV. The RAF Typhoon is thus moving beyond only air-to-air capability to air-to-ground. Once fully operational, the Typhoon will be able to drop eight Paveway IVs on eight different targets in one pass.

Sukhoi Su-35s for China

The most prominent foreign exhibitor at *Airshow China 2014* was Russia, which showcased its Su-35S single-seat fighter apart from the Sukhoi Su-27s of the 'Russian Knights' aerobatic team. It has been unofficially announced that the PLAAF is seeking 24 Su-35s and according to Boris Bregman, Sukhoi's first deputy director general, Russia is ready to supply 'standard' Su-35 versions to China, but integration of Chinese equipment will be a supplementary contract, a process that could take considerable time because extensive flight tests and weapon launches will be required to modify the aircraft. A Sino-Russian contract for the Su-35 could be signed in early 2015, but observers feel that Russia is extremely

wary of China as it has initiated 'reverse engineering' in the past when Su-27SKs were transformed into becoming J-11s.

Doubtless, the PLAAF is interested in the Su-35's technology including the Tikhomirov NIIP Irbis-E passive electronically scanned array radar, as well as its NPO Saturn 117S engines. Ever since Russia has become internationally isolated owing to the situation in Ukraine, a side effect is the reinvigoration of political relations with China. Further evidence of this strategic co-operation was the recent sale of another batch of 100 RD-93 turbofans to China before the end of 2016 for use on Pakistani JF-17 fighters, even as efforts are on to increase the RD-93's thrust.

Polish Air Force MiG-29 upgraded

Upgrade of 16 Polish Air Force MiG-29s has been completed. Under a $39.5 million contract signed in August 2011, *Wojskowych Zakladow Lotniczych 2* (WZL 2 – Military Aviation Plant No 2) at Bydgoszcz was to carry out modernization of 13 single-seat MiG-29As and three twin-seat MiG-29UBs, which are assigned to 1 *Eskadrze Lotnictwa Taktycznego* (ELT – Tactical Air Squadron) at Minsk Mazowiecki. Upgrade work includes a new open-architecture avionics suite with a new multi-function colour display, mission computer, up-front control panel, digital video recorder and databus, INS/GPS navigation and Rockwell Collins RT-8200 UHF/VHF radio. A life-extension programme is also part of the upgrade, which should see the type remain in Polish service until around 2028.

US Navy's 19th P-8A Poseidon delivered

Boeing delivered the 19th P-8A Poseidon to the US Navy on 20 November for service with Patrol Squadron 16 (VP-16) 'War Eagles', the US Navy's first operational Poseidon unit. The aircraft is the sixth of 11 aircraft in low-rate initial production (LRIP) Lot III.

US Navy's 200th MH-60R

Lockheed Martin has delivered the 200th Sikorsky MH-60R 'Romeo' submarine-hunting helicopter to the US Navy on 12 November. Enhancing the US Navy's anti-surface and anti-submarine operations, MH-60Rs have flown more than 250,000 hous with the Fleet, providing increased surveillance and situational awareness. The US Navy has ordered 291 MH-60R helicopters even as 24 are ordered for the Royal Australian Navy and nine for the Royal Danish Navy.

Raytheon Next-Generation Jammer

Raytheon has successfully tested a Next-Generatiom Jammer (NGJ) pod during flight trials at Naval Air Weapons Station China Lake, California. The test was carried out with the pod mounted underneath Calspan Corporation's Gulfstream III business jet test-bed system which consisted of an active electronically scanned array (AESA), an all-digital, open, scalable receiver and techniques generator and a self-powered pod.

The high-powered AESA front end and multichannel techniques generator are common building blocks not just for the US Navy's NGJ, but also for other airborne, maritime and ground-based EW systems. The NGJ is planned to replace the current analogue AN/ALQ-99 tactical jamming system carried by the US Navy's Boeing EA-18G Growler. A team of engineering and technical personnel

collected and evaluated test data confirming the successful jamming and disruption of air defence radars, which were representative of enemy threat radars. "The combination of jamming techniques, beam agility, array-transmit power and jammer-management were very effective against the threat systems and all test objectives were either met or exceeded," according to Raytheon.

Mi-171Sh for Peru

Russian Helicopters have delivered to Peru the first batch of four Mi-171Sh military transport helicopters, built by Ulan-Ude Aviation Plant "a month ahead of schedule". A contract was signed in December 2013 for 24 helicopters, eight due in 2014, with the rest to follow in 2015. A maintenance centre for Russian Helicopters will also be established in Peru, the Mi-171s to be used in counter-narcotics and counter –terrorism operations.

Il-76MD-90A in AWACS conversion

The Beriev Aircraft Company has received the first of Il-76MD-90A transport aircraft for conversion into the first A-100 airborne warning and control system (AWACS) aircraft prototype, the aircraft arriving at Beriev's Taganrog facility on 21 November. The A-100 is being developed as a replacement for the Russian Air Force's current A-50U AWACS aircraft, an upgraded version of the original A-50, and is based on the new Il-76MD-90A airframe (designated the Il-476), which is a re-engined and upgraded Il-76 on which the A-50 is essentially based. The new variant has more powerful PS90A-76 turbofans and numerous enhancements.

Israel's 'Mighty' F-35As

Israel's cabinet has decided to purchase 14 Lockheed Martin F-35A Lightning IIs for the Israeli Air Force, with authorisation given for an order which will also include 17 more aircraft. The first of the initial 14 are to arrive in Israel in 2019. Of the 14 aircraft ordered, 13 will enter operational service and one will be used for development and integration of Israeli-specific systems. Israel has already ordered 19 F-35As (locally designated the F-35I). A contract covering long-lead items for the first two IAF aircraft was awarded to Lockheed Martin on 2 May 2013, as part of Low-Rate Initial Production (LRIP) Lot VIII, by a full production contract in November2014. Deliveries from the initial order are expected to begin in December 2016, with the first two arriving early in Israel in early 2017 and all 19 in service by 2018. In Israeli service the type will be known as the *Adir* (Hebrew for 'Mighty').

Czech Republic extends Gripen lease

Under a Government-Government agreement, the Swedish Defence Materiel Administration (FMV) has extended the lease of Gripens from Sweden to the Czech Republic, for a further 12 years. Gripen has been in service with the Czech Air Force since 2005, and in May 2014 a new agreement between Sweden and the Czech Republic extended this partnership. The Czech AF will continue to operate 14 Gripen C/D aircraft until at least 2027.

Embraer KC-390 makes maiden flight

On 3 February 2015, the Embraer KC-390 military transport and mid-air refueller successfully performed its first flight. The test flight aircrew carried out maneuvers to evaluate flight

characteristics and conducted a variety of system tests, which were earlier subjected to intensive ground testing and simulations.

The KC-390 is a joint programme between the Brazilian Air Force and Embraer to develop and produce a new generation tactical military transport and mid air refueller, one which represents significant advance in technology for the Brazilian aeronautics industry. The KC-390 has been designed to "set new standards in its class, at a lower operational cost and with flexibility to perform a wide range of missions: transport and airdropping of cargo and troops, aerial refueling, search and rescue, and forest fire fighting, among others".

On 20 May 2014, Embraer and the Brazilian Air Force had signed the contract for serial production involving 28 KC-390 aircraft plus initial logistic support. Apart from the Brazilian Air Force requirement, there are presently letters of intent for an additional 32 aircraft for export.

Egyptian Apaches

Ten Boeing AH-64 Apaches have been delivered to the Egyptian Air Force, after some delay. In October 2013, military aid to Egypt had been suspended owing to continuing violence in the country after a coup that ousted Egyptian President Mohammed

Morsi, which immediately put a block on the proposed Apache deliveries. In April 2014, the US approved lifting of the ban, allowing the delivery to go ahead. Initially Egypt had sought 12 Apaches, but the final deal was for ten. On 20 December 2012, Boeing was awarded a contract to procure these AH-64s for Egypt, with an estimated completion date of 30 June 2014.

Vietnamese Air Force C295Ms

The Vietnamese Air Force has received its first Airbus C295M, initially retained in Spain for training of VPAF personnel. The deal was signed in 2013 and the aircraft are in standard transport configuration.

Ecuadorean C295Ms

The third Airbus C295M for the *Fuerza Aérea Ecuatoriana* (FAE – Ecuador Air Force) was delivered on 28 November to serve with *Ala de Transporte* 11's *Escuadrón* No 1112. The C295Ms are replacing the weary Avro 748s, the first of which had entered service in 1970 and have progressively been withdrawn from operations over the last few years.

Gulfstream G450 for PAF

Another Gulfstream G450 has been acquired by the Pakistan Air Force, albeit a 'used' one. Carrying only its construction number as a serial on the fin and using callsign 'PAK4270', the Gulfstream had been delivered new in March 2013 to a civilian owner when it left the factory in Savannah, Georgia. It was being offered for sale by US business jet sales and consulting company Avpro, but was withdrawn from the market in July, suggesting that a deal with Pakistan was probably confirmed.

Bangladesh receives K-8s

First of nine Chinese-origin Hongdu K-8 advanced jet trainers were delivered to the Bangladesh Air Force in early December 2014. These will replace the elderly Cessna T-37s which were earlier transferred to the BAF from the PAF, which too is operating the K-8 Karakoram in the advanced jet training role. In addition Bangladesh will shortly induct 16 Yak-130 advanced jet trainers from Russia's Irkut which will be suitable as lead-in fighter trainers for the Chengdu J-7 and RAC MiG-29 fighters in service, as also for light attack tasks.

File photo of Chinese JL-8/K-8 advanced jet trainer

Chinese Y-20 Kunpeng heavy lift transporter

Various transport aircraft types from the Xian Aircraft Industrial Corporation (XAC) debuted at *Airshow China 2014* including the Y-20 Kunpeng which is needed for the PLAAF's future airlift capacity. The Y-20's payload is estimated at 66 tonnes, which, with a range of 4500 km will give the PLAAF greater strategic reach. The Y-20 is currently powered by Russian-supplied jet engines, but in the future China is to equip its Kunpeng transporter (a mythical Chinese bird that flies long distances) with more powerful, locally produced WS-20 engines delivering 132kN. However, series production of the Y-20 will be dependent on these new Chinese engines successfully completing their development. China is seeking to mature its engine production capabilities so as to be less dependent on Russia for high-performance powerplants.

F-35 cost reduction moves

According to reliable reports, Lockheed Martin and the US government have finalised the follow on programme to produce 43 F-35 Lightning II combat aircraft. Included in the low-rate initial production (LRIP) deal are 29 aircraft for the USAF and 14 to be delivered to five international operators along with an allocation to cover advanced procurement funding for later production lots. According to an official spokesman, "the LRIP 8 contract terms continue to eliminate the government's exposure to risk by having Lockheed Martin cover 100% of any cost overruns." Additionally, "the government and Lockheed Martin will share returns derived from any under runs in target cost" at a respective 205 to 80% ratio. The F-35 joint programme office (JPO) has given the per-variant airframe costs as $94.8 million for the conventional take-off and landing F-35A, $102 million per short take-off and vertical landing F-35B and $115.7 million for each carrier-variant F-35C. These figures exclude the cost of the type's Pratt & Whitney F135 engine, which will be purchased separately.

Under its LRIP 8 contract, the US Department of Defence is to procure 19 F-35As for the US Air Force, six F-35Bs for the US Marine Corps and four F-35Cs for the US Navy. The deal also includes the first two and four F-35As respectively, for Israel and Japan, and two each for Italy and Norway, plus the first four production F-35Bs to be built for the UK, with deliveries in 2016. 115 F-35s have so far been delivered to the US armed services, plus initial operational test and evaluation aircraft to the UK and Netherlands.

First Airbus A400M for Germany and the UK

Airbus Defence and Space has delivered the first Airbus A400M military transport ordered by Germany, being the ninth aircraft delivered so far and in service with four nations. Bernhard Gerwert, CEO Airbus Defence and Space, said: "We are extremely proud to hand over the first A400M to Germany. The A400M will play a critical role in the modernisation of Germany's air mobility force. The unique combination of strategic and tactical capabilities, allied to a level of reliability greater than that of the previous generation aircraft that it is replacing, will transform the German Air Force's transport operations in the coming years." The A400M will replace the C-160 Transall in Luftwaffe service.

Airbus has also delivered the first Airbus A400M new generation airlifter to the Royal Air Force, the first of 22 ordered by the UK which will be known in service as the A400M 'Atlas'. The A400M will replace the C-130 Hercules in RAF service but, "because it can carry approximately twice as much load, or the same load twice as far, fewer aircraft will be required." At Brize Norton the A400M will operate alongside the RAF's Airbus Voyager multi-role tanker transport fleet. The wings of both aircraft are built in the UK at Filton and Broughton respectively. Additionally the Voyager's engines are produced in the UK by Rolls-Royce, which is also a member of the Europrop International consortium that produces the A400M's TP400 engines.

First Airbus A400M for Malaysia rolled out

The first Airbus A400M airlifter for the Royal Malaysian Air Force has now been painted in its new colours at the Airbus Defence and Space facility in Seville, Spain. In the coming weeks the aircraft, known as MSN22, will perform its first ground tests and flights before delivery. RMAF pilots, maintenance engineers and technicians are already undergoing instruction at the Airbus Defence and Space International Training Centre.

The photo above shows the aircraft in RMAF colours

Four more C-17 Globemaster IIIs for Australia

The Royal Australian Air Force is to procure four additional C-17 Globemaster III aircraft and associated equipment, parts and logistical support for an estimated cost of $1.609 billion. These include 19 F117-PW-100 Pratt & Whitney engines, 4 AN/AAQ-24V Large Aircraft Infrared Countermeasures (LAIRCM) Systems,

4 Small Laser Transmitter Assemblies, 4 System Processors, 4 AN/AAR-54 Missile Warning Sensors, 1 AN/ALE-47 Countermeasure Dispenser, 1 AN/AAR-47 Missile Warning System, 5 Trimble Force 524 Receivers, 2 GAS-1 Antenna Units, 2 Controlled Reception Pattern Antennas, 1 AN-USC-43V Advanced Narrowband Voice Terminal, 16 Honeywell H-764 ACE Embedded Global Positioning System/Inertial Navigation Systems, spare and repair parts, supply and test equipment, personnel training and training equipment, publications and technical documentation, United States Government and contractor engineering, logistics, and technical support services, and other related elements of logistics support.

Airbus Helicopters delivers NH90 and HAD-E Tigers to Spain

Airbus Helicopters has delivered the first two Tiger helicopters in the new HAD-E version and the first NH90 GSPA tactical transport helicopter to the Spanish Army Airmobile Force (FAMET). These helicopters were assembled at the Spanish plant in Albacete. Airbus Helicopters España will supply a total of 22 NH90 helicopters to the Spanish Armed Forces under a delivery schedule that continues through to 2021. The Spanish plant is responsible for assembly of all the NH90 helicopters for the Spanish Armed Forces, along with manufacture of the front fuselage section both for the Spanish helicopters and for export variants.

The Tiger HAD-E version offers numerous advantages over those currently in service: a new MTR-E turboshaft with 14% more power, an improved optronic vision system, Spike air-to-ground missiles, an Identification Friend or Foe (IFF) system coupled with

an interrogator and a new electronic warfare and countermeasure system.

The Spanish Army has ordered 24 of these helicopters of which six Tigers have been delivered to the Attack Helicopter Battalion.

MBDA Storm Shadow released from Typhoon

Alenia Aermacchi, working with its Eurofighter partners, has successfully conducted first release of a Storm Shadow missile from a Eurofighter Typhoon aircraft as part of its missile integration programme. The trials took place in November 2014 and had the missile being released from the aircraft and tracked by radar till impact. Storm Shadow provides a significant leap in the Eurofighter Typhoon's operational capabilities, enabling the platform to deploy multiple weapons at a very long range well clear of danger from air defences.

In parallel to the flight trials led by Alenia Aermacchi, BAE Systems, has completed the first trial installation of a Storm Shadow missile onto a RAF Typhoon with support from weapons provider MBDA. Storm Shadow, already in service with the Italian Air Force and Royal Air Force Tornados, is a conventionally armed, stealthy, long-range stand-off precision weapon designed to neutralise high value targets.

Raytheon AMRAAM and NASAMS exercised

Armed forces of Norway, Finland, Switzerland and Turkey successfully fired five Raytheon-built Advanced Medium Range Air-to-Air Missile (AMRAAM) AIM-120C7s as part of the *Thor's Hammer* flight test campaign in September 2014. Launched from F-16s and F/A-18s, plus the National Advanced Surface-to-Air Missile System (NASAMS) ground launchers, the missiles achieved five successful hits on a variety of profiles and targets.

C-130J Super Hercules for Tunisia

Tunisia has received its second C-130J Super Hercules. Lockheed Martin had signed a contract in 2010 with Tunisia to deliver two C-130Js, as well as to provide training and an initial three years of logistics support. Tunisia received its first C-130J in April 2013, marking the first delivery of a J-model to an African nation.

Tunisia's new C-130Js are the longer fuselage or 'stretched' variant of the aircraft and will be used to support operations across the mission spectrum, including relief efforts, firefighting and traditional airlift sorties. With more than 1.2 million flight hours to date, the C-130J is available in nine variants and offers operators 17 different mission configurations.

Italian AF orders more M-346s

Finmeccanica-Alenia Aermacchi and Armaereo will provide the Italian Air Force with further three M-346s plus ground base training system and relevant logistic support included. The contract is part of the agreement signed by the parties in 2009 for the supply of 15 M-346s.

Chinese UAVs

At *Airshow China 2014* were displayed an array of Chinese-developed unmanned aerial vehicles (UAV) with increasing models in evidence. An example was the 1100 kg Wing-Loong 1 unmanned combat aerial vehicle (UCAV) from the Chengdu Aircraft Industry displayed in PLAAF markings. The 1260kg CH-4 manufactured by the China Aerospace Science and Technology Corporation (CASC) is reportedly already in PLAAF service, and was operated during the PLA's 'Peace Mission 2014' exercise in August.

The PLAAF now has two high-altitude, long-endurance (HALE) UCAVs in service, with the 4000km-range Wing-Loong 1 already having achieved overseas sales. Other UAVs included the Chengdu Aircraft Design and Research Institute (CADI) 30kg Nimble-Loong with 150km mission radius also being promoted for civilian tasks such as meteorological measurements and patrolling of power lines. Another CADI craft at Zhuhai was the Tianyi-1, a UAV already in use by China's State Environmental Protection Department. CADI also displayed a model of the fixed-wing VD200 vertical take-off and landing (VTOL) UAV, which transitions to fixed-wing horizontal flight.

Airbus DS surveillance radar for German Air Force

Airbus Defence and Space is to equip the military airfields in Germany with the most powerful airport surveillance radar (ASR) extant which will increase flight safety and improve the efficient use of airspace. With the inauguration of the first ASR system at Air Wing 33's Büchel Airbase the company started the hand-over of 23 radars which are under contract within a €250 million upgrade programme of the German procurement authority. The ASR systems will replace the 30-year-old radars which have been used until now in military air traffic control. The new radars will be used for approach control at the airfield itself and for airspace surveillance within a radius of 60nm (110km) to safely coordinate, amongst other things, military flight movements with civil air traffic.

Russian Helicopters flight testing of Mi-171A2

Russian Helicopters (part of State Corporation Rostec) began flight tests on first prototype of the Mi-171A2 multirole helicopter in October 2014. During its maiden flight its main systems were tested and found to be in "excellent working order", according to test pilot Salavat Sadriev. First prototype of the

Mi-171A2 is equipped with the KBO-17 avionics suite which is testing interoperability with the new VK-2500PS-03 engines. The new helicopter's rotor system and engine were earlier tested in a Mi-171LL flying testbed.

The KBO-17 avionics suite is built by Radioelectronic Technologies, and includes all-weather digital TV and thermal imaging cameras, providing external visibility day or night, with the video output given on a high-resolution multifunction display.

New main and tail rotors, redesigned vertical and horizontal fins will be incorporated in second prototype of the Mi-171A2 which will also incorporate an external sling for carriage of up to 5 tonnes and energy absorbing passenger seats for 24 people. This example is being assembled and equipped at the Mil Moscow Helicopter Plant.

Russian Helicopters starts final certification tests on the Mi-38

Russian Helicopters' Mil Moscow Helicopter Plant is engaged in final stage of certification testing on the Mi-38 multirole helicopter with two prototypes fitted with TV7-117V engines. On 20 October 2014, it successfully completed a series of hover tests and low-speed ground runs, after which it was transported overland to the Mil Moscow Helicopter Plant. On 3 November 2014 was received the fourth Mi-38 prototype, built by Kazan Helicopters which joined certification flight testing.

The fourth Mi-38 prototype will be fitted with the full suite of on-board data acquisition systems, which will lead to final certification scheduled for 2015. The Mi-38, a medium-lift multirole helicopter, designed in accordance with AP-29 aircraft certification requirements, is equipped with highly efficient Russian-made TV7-117 engines and an integrated digital flight navigation system with five LCD displays.

Russian Helicopters' Ansat certified

Russian Helicopters has received additional certification from the Aviation Register of the Interstate Aviation Committee (AR IAC), for the Ansat light multirole commercial helicopter. First deliveries will take place in 2015. The Ansat passenger variant has an upgraded stability augmentation system, increased take-off weight (to 3,600 kg), which has improved the helicopter's flight performance and made it more competitive for the international market.

50th Bell 429 in Europe

Bell Helicopter has delivered the 50th Bell 429 in Europe to an operator in the United Kingdom. The Bell 429 currently operates in various commercial roles in Europe, including the Turkish National Police, National Grid and Air Zermatt.

Airbus Helicopters delivers TH-135s to JMSDF

Airbus Helicopters Japan has handed over three TH-135 training helicopters to the Japan Maritime Self-Defence Force (JMSDF). The TH-135 is a variant of Airbus Helicopters' light twin-engine EC135 T2+ which has been adapted for the JMSDF.

Deliveries of the TH-135 began in 2009 and a total of some 1,200 EC135s have been delivered worldwide for a variety of missions ranging from pilot training and law enforcement to emergency medical services and search and rescue. The high operation rate and ease of maintenance contributing to its low life-cycle cost has made the EC135 a useful helicopter in Japan, where about 80 such helicopter types are in operation

AW169 full scale production

AgustaWestland's new generation AW169 light intermediate 4.5-tonne class helicopter has entered full scale production, at the Vergiate facility in Italy. The event marks a major milestone ahead of EASA certification, with deliveries to the first batch of customers set to start in the second quarter of 2015. The AW169 is the first all new aircraft in its weight category to enter the market in nearly forty years.

The AW169 flight test programme, utilising four prototypes, has so far amassed over 1200 flying hours during flight testing in Italy, the UK and USA. A second AW169 final assembly line is planned at AgustaWestland's Philadelphia plant in the US, while AgustaWestland's Yeovil plant in UK is already producing rotor blades and tail rotor transmission system. Parallel to the start of full scale production, AW169 training systems are being established at AgustaWestland's Sesto Calende Training Academy in Italy, including a level-D full flight simulator and maintenance trainer.

Azul and Loong Air select CFM LEAP-1A to power A320neos

Azul Brazilian Airlines has selected CFM International's advanced LEAP-1A engine to power 35 Airbus A320neo family aircraft, at an order worth over $900 million. The airline will also lease 28 additional aircraft powered by LEAP-1A engines. "We like what we see in the LEAP engine," said David Neeleman, CEO and founder of Azul. "The technology is cutting edge and, along with the airplane, will allow us to reduce operating costs and increase capacity with the most advanced engine in its category." The airline plans to use the A320neo aircraft to connect to more Brazilian cities, offering even more seats on its longer haul flights and reducing operating costs.

Meanwhile, China's Zhejiang Loong Airlines has signed an agreement with CFM International to purchase LEAP-1A engines to power nine Airbus A320neo aircraft. The airline, based in Hangzhou in Eastern China, began commercial operations in December 2013 with two CFM56-5B-powered Airbus A320 aircraft and has since added seven additional airplanes to its fleet.

Boeing selects GE for 777X Avionics Systems

GE Aviation has been selected by Boeing to provide the Common Core System (CCS) and the Enhanced Airborne Flight Recorder (EAFR) for the Boeing 777X aircraft. Selecting the GE common core system and enhanced airborne flight recorder enables Boeing to bring the latest generation of proven capabilities from the 787 to the 777X. There are 300 orders for the 777X and commitments from customers Lufthansa, Etihad, Qatar, Emirates, ANA and Cathay Pacific. The latest systems technology for the 777X involve two major GE Aviation facilities including the common core system and the enhanced airborne flight recorder from Grand Rapids, Michigan and the remote data concentrators from Cheltenham, United Kingdom.

2,000th GE90 engine delivered

GE Aviation has supplied its 2000th GE90 engine to Boeing for its 777, a significant milestone in this engine programme. Close to 70 operators utilise GE90-powered Boeing 777 aircraft, with the 2000th engine powering a Boeing 777-300ER aircraft. The GE90 engine family powers all the Boeing 777 models and is the exclusive powerplant on the 777-300ER, -200LR, and Freighter aircraft. Of the 2000 GE90 engine delivered to date, more than 400 were the earlier GE90-94B model and almost 1600 were the GE90-115B engine, which is the world's most powerful jet engine. The family has accumulated more than 45 million flight hours and 7 million cycles since entering service in 1995.

The GE90 engine provides foundation for the new GE9X engine that will power the Boeing 777X aircraft, and will be in the 100,000 pound thrust class and features a 133-inch diameter composite fan case and 16 composite fan blades; a next-generation 27:1 pressure-ratio 11-stage high-pressure compressor; a third-generation TAPS III combustor for high efficiency and low emissions; and CMC material in the combustor and turbine.

Lion Air orders 40 ATR 72-600s

Prime Minister Matteo Renzi and Finmeccanica's CEO and General Manager, Mauro Moretti were at the contractual ceremony for 40 ATR 72-600 aircraft, to meet the growing demand for short and medium haul air transport in the Indonesian and Southeastern Asia region.

Thales avionics on Lion Air's A320s

Thales will provide its avionics package on all 234 new Airbus A320 airliners purchased by Lion Air, which represents the largest order for Airbus single-aisle aircraft ever placed. Lion Air, whose entire ATR feet has Thales systems, is Indonesia's largest private airline and one of the fastest growing carriers in South East Asia. The avionics suite fitted on the new airliners will include the Thales TopFlight Management System, which, with over 60% market share, is the preferred choice for Airbus single-aisle aircraft. The avionics suite on the new A320 fleet will include the ACSS T3CAS surveillance platform2. Lion Air joins a fast growing list of airlines (including, China Eastern, Air Asia and Cebu Pacific) that have selected this new generation surveillance platform for their fleets.

GECAS sign for 15 Q400 NextGen

Lessor GE Capital Aviation Services (GECAS) has signed a firm purchase agreement for five Bombardier Q400 NextGen aircraft and has also taken options on an additional 10 Q400 NextGen aircraft. Based on the list price of the Q400 NextGen aircraft, the firm order is valued at approximately US $160 million. The value could increase to US $448 million should GECAS exercise all its options.

Airbus exceeds targets in 2014

Airbus has exceeded its targets for 2014, achieving a new record of 629 aircraft deliveries to 89 customers of which eight are new. These comprised 490 A320 Family aircraft, 108 A330s, 30 A380s and also the first A350 XWB. Airbus' aircraft deliveries in 2014 were up for the 13th year in a row, surpassing the previous record set in 2013. Airbus also achieved 1,456 net orders from 67 customers (of which 14 are new), comprising 1,321 single aisle aircraft and 135 widebodies. By year end, the backlog had climbed to a new industry record of 6,386 aircraft valued at US$ 919.3 billion at list prices.

Milestone of the year was completion of A350 XWB testing and certification culminating in the on-time delivery of the first aircraft for Qatar Airways *(see article)*. 30 A380s were delivered and Asiana, Qatar Airways and Etihad became new operators of this flagship aircraft. AsA330neo development programme gains momentum, the A330ceo continues to benefit from incremental innovation. The A320neo programme is proceeding on track following its first flight September 2014, paving the way for certification in Q3 and first deliveries in Q4.

Finnair's first A350 XWB takes shape

The first A350-900 for Finnair is taking shape in the Roger Béteille Final Assembly Line (FAL) in Toulouse, France. Finnair will be the first European airline to fly the A350 XWB and the third operator in the world. Scheduled for delivery in autumn 2015, the aircraft is now in the fuselage section joining phase. Following this, the aircraft will move to wing junction, cabin installation and first power-on, all achieved in one single station. Once these phases are completed, the aircraft will undergo system tests, cabin completion, painting and engine installation before starting the delivery process, including flight testing. Finnair has a total of 19 A350 XWB on order. The aircraft will be deployed on Finnair's long-haul routes to Asia and America.

Etihad Airways receives 1st Airbus A380

At a ceremony in Abu Dhabi, Etihad Airways inducted the first of ten new Airbus A380 aircraft. Etihad Airways is the thirteenth airline to operate the A380, and the aircraft is the 150th A380 delivered by Airbus. The delivery will boost capacity on several of Etihad's most in-demand routes, "taking the airline to new heights as it continues to redefine the flying experience." Etihad's A380 is designed to carry 498 passengers in four living spaces on the aircraft, including two VIP guests in *The Residence by Etihad*, nine guests in the *First Apartments,* 70 guests in the *Business Studio,* and 417 guests in *Economy SmartSeats*. Equipped with the latest entertainment systems and the plush surroundings of Etihad Airways' interior, passengers can expect "an exceptionally comfortable journey."

AirAsia X places firm order for 55 A330neo

AirAsia X, the long haul affiliate of Asia's largest low-cost airline, has placed a firm order with Airbus for 55 A330neo aircraft. This is the largest single order to date for the A330 Family and reaffirms AirAsia X's position as the biggest A330 airline customer worldwide, having now ordered a total of 91 aircraft. The announcement covers the firming of order for 50 A330neo signed during the Farnborough Air Show in July 2014, plus an additional five aircraft. Deliveries of the newly-ordered aircraft will begin in 2018.

Building on the proven economics, versatility and reliability of the A330ceo, the A330neo will incorporate latest generation Rolls-Royce Trent 7000 engines, aerodynamic enhancements and new cabin features.

Frontier Airlines orders 9 Airbus A321ceo aircraft

Frontier Airlines has placed a firm order for nine Airbus A321ceo (current engine option) aircraft, the first time Frontier has ordered this largest member of the Airbus A320 Family. The airline currently flies a fleet of 35 A319ceo and 20 A320ceo aircraft. In addition, Frontier has on its order backlog 80 A320neo (new engine option) family aircraft. Including the latest order, Frontier has a backlog of 89 Airbus single-aisle aircraft. The airline however has not yet announced its engine selection or the seating configuration for its A321s.

Delta orders 50 Airbus A350s

Delta Air Lines has placed a firm order for 50 new Airbus widebody aircraft, 25 A350-900 and 25 A330-900neo aircraft. Rolls-Royce Trent 7000 engines will power the Airbus A330neo aircraft and Trent XWB engines will power Airbus A350 XWB aircraft. Delta Air Lines currently flies both Airbus single-aisle and widebody aircraft, including 57 A319ceo and 69 A320ceo aircraft, plus 11 A330-200s and 21 A330-300s. In addition to the latest order, Delta has an order backlog of 10 A330-300s and 45 A321ceo aircraft, bringing its total Airbus backlog to 105 aircraft.

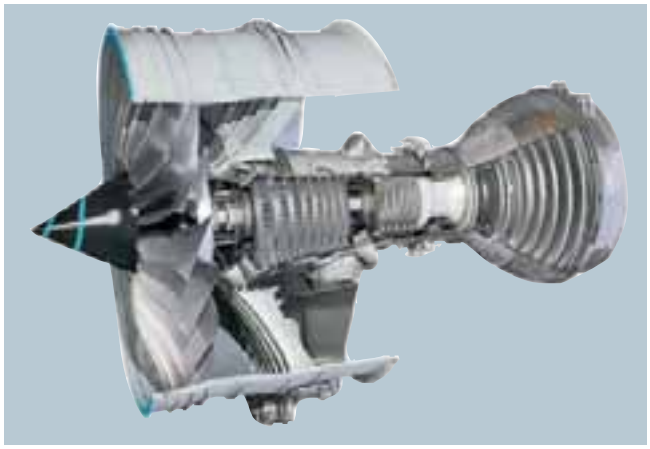
Boeing Commercial Airplanes in milestone deliveries

Boeing has achieved a record for "the most commercial airplanes delivered in a single year" at 723 in 2014, breaking the company record for a second consecutive year. The company's sales team also booked 1,432 net orders, for the value of $232.7 billion at, breaking the previous all-time high set in 2007. Boeing's unfilled commercial orders stood at 5,789 at the end of the year, also a new all-time high for the company.

Of the 1,432 net commercial orders Boeing booked in 2014, the Next-Generation 737 and 737 MAX led with 1,104 orders, followed by the 777 and 777X with 283 orders. Boeing continues to bring new products and services to the market, including launch of the 737 MAX 200 in September, which can accommodate up to 200 passengers, increasing revenue potential and providing customers up to 20 per cent better fuel efficiency.

Rolls-Royce Trent ordered by Delta Air Lines

Rolls-Royce has won a $5bn order for Trent engines and long-term TotalCare service support from Delta Air Lines to power 50 new aircraft. Trent XWB engines will power 25 Airbus A350s and Trent 7000 engines will power 25 Airbus A330neo aircraft.



Record year for ATR

In 2014 ATR surpassed 2013's records in sales; deliveries, turnover and backlog, the aircraft's sales increasing to 160 aircraft, along with 120 options, exceeding the previous 2011 record (157 firm sales and 79 options). ATR also achieved a record turnover in 2014, reaching 1.8 billion dollars (1.63 billion in 2013), and increased its deliveries to 83 aircraft (compared with 74 in 2013). As a result of the extraordinary commercial year experienced by ATR, 2014 ended with 280 aircraft in its backlog, an end-of-year level never reached until now. Since the start of the programme in 1981, ATR has sold 1470 aircraft (470 ATR 42s and 1000 ATR 72s).

Rolls-Royce Trent to power Air Asia X aircraft

The Rolls-Royce Trent engine has been selected by AirAsia X to power 10 Airbus A330ceo and 55 Airbus A330neo aircraft with engines and long-term TotalCare support worth $6.2bn. The A330ceos will be powered by the Trent 700 and the A330neos by the recently-launched Trent 7000 engine. The airline had previously ordered 25 A330ceos, powered by another provider, and this has now been altered to ten aircraft, powered by the Trent 700.

This is the largest order for the Trent 7000 engine since it was launched. The selection takes the firm AirAsia X A330ceo/A330neo fleet to 96, including aircraft sourced from operating leases, which make the airline the largest operator of the A330 family, all powered by Rolls-Royce engines.

CFM's LEAP engine certification test programme

CFM International's LEAP engine is performing "exceptionally well" in ground and flight testing on the path to engine certification and flight tests on the Airbus A320neo and COMAC C919 in 2015. The engine flew for the first time on 6 October on a modified 747 flying testbed at GE Aviation Flight Test Operations in Victorville, California, and has to date completed more than 75 total hours of flight testing.

CFM is currently executing the most extensive ground and flight test certification programme in its history. The total programme, which encompasses all three LEAP engine variants, includes 28 ground and CFM flight test engines, along with a total of 32 flight test engines for Airbus, Boeing, and COMAC. The engine has successfully completed more than 2,600 cycles on many of the most demanding tests, including early icing; cross wind; bird ingestion; emissions; acoustics; and early endurance testing.

Airbus Group and Safran in JV

Airbus Group and Safran have created the new Joint Venture, Airbus Safran Launchers. With an initial workforce of around 450, starting operations on 1 January 2015, Airbus Safran Launchers will maintain the outstanding level of quality and reliability of Ariane 5, while working on a new family of state-of-the-art space launchers to foster Europe's leading role in the space industry. The Joint Venture's headquarters will be located in Issy-les-Moulineaux, near Paris.

Bell 505 Jet Ranger powered by Turbomeca's Arrius 2R

The Bell 505 Jet Ranger X powered by the Turbomeca (Safran) Arrius 2R engine made its maiden flight on 10 November 2014 at the Bell Helicopter Mirabel facility. Turbomeca Chairman & CEO Olivier Andriès was "delighted that a company with such a high reputation for product quality and support trusts us to support such an important programme".

The Arrius 2R made its first ground test on 29 April 2014 at the company's Bordes factory and FAA, EASA and Transport Canada engine type certifications are planned for the end of 2015. The Arrius 2R is designed to deliver performance and power within the 500 shaft horsepower range, while improving safety and lowering pilot workload via a Full Authority Dual-channel Engine Control (FADEC).

GE T64-GE-419 engines on Bell V-280 Valor demonstrator

GE Aviation's T64-GE-419 engine will power the Bell V-280 Valor demonstrator aircraft which has been selected within the Joint Multi Role Technology Demonstrator (JMR-TD) initiative. JMR-TD is intended to reduce risk and validate requirements for the Department of Defence Future Vertical Lift (FVL) initiative, a programme which will create the next generation of vertical lift aircraft for the US military.

Bell Boeing demonstrates V-22 Osprey forward-firing capability

Forward-firing capability for the Bell Boeing V-22 Osprey was demonstrated at the United States Army Proving Ground in Yuma, Arizona. Since its deployment in 2007, the V-22 has achieved "outstanding mission success" in deployments to Afghanistan,

the Persian Gulf and the Mediterranean. The Osprey has a wide range of mission capabilities including induction of Special Forces, casualty evacuation, tactical recovery of aircraft and personnel, humanitarian assistance/disaster relief, resupply, VIP transport, and theatre security cooperation. Through the end of the third quarter of 2014, Bell Boeing has delivered 242 MV-22 tiltrotor for the Marine Corps and 44 CV-22 for Air Force Special Operations Command (AFSOC).

Airbus DS to modernise the German Armed Forces' identification systems

Airbus Defence and Space will upgrade the German Armed Forces' identification systems to NATO's new 'Mode 5' IFF (identification-friend-or-foe) standard which will improve the distinction of friendly and hostile forces and thus help to avoid

friendly fire. The German procurement authority has awarded Airbus a follow-on contract to upgrade the existing IFF interrogator and transponder equipment. The contract covers the adaptation to Mode 5 standard of the existing STR 2000 transponders onboard all flying platforms of the German Armed Forces.

IFF systems or secondary surveillance radars (SSR), precisely identify ships and aircraft by automatically sending interrogation signals which are answered by 'transponders' on-board the incoming aircraft or ship. Thus, IFF enables field commanders to quickly distinguish friendly from hostile forces. Unlike Mode 4 used hitherto, Mode 5 employs sophisticated encryption techniques to avoid hostile signal manipulation, thus ensuring that the identification process is absolutely reliable and secure.

40th anniversary of Turbomeca Arriel's first flight

Turbomeca (Safran) has celebrated 40th anniversary of the first flight of the Arriel engine, which first flew in a Gazelle helicopter on 7 December 1974. The first two variants, Arriel 1A for the Dauphin and Arriel 1B for the Ecureuil, were certified in June 1977. Turbomeca Chairman & CEO Olivier Andriès recalled the "rich history" of the Arriel engine, adding that there is "still so much to be written."

Over the past 40 years around 11,500 Arriel units have been produced, achieving more than 42 million flight hours. With power outputs ranging from 650 to 950 shp, the Arriel family now powers over 40 different helicopters. Its latest model, Arriel 2E for the EC145 T2, was certified in December 2012 and entered service in August 2014.

RN forms UAV Squadron

The Fleet Air Arm (FAA) has formed at Culdrose in Cornwall its first unmanned aircraft squadron (700X). The Navy has operated the Boeing ScanEagle from Type 23 frigates in the Arabian Sea on counter-piracy patrols. ScanEagle can remain airborne for 12 hours, operating up to 40 miles (64km) from its ship, beaming live video through its electro-optical and infrared camera, by day or night, into the ship's operating room. Initially supporting the Navy's minehunters in the Gulf, it has proved equally useful for counter-piracy and counter-smuggling.

RBS15 Mk3 Sea Acceptance trials

The Polish Navy have conducted successful commissioning and sea acceptance tests of the Saab RBS15 Mk3 onboard the *Orkan*-class fast attack craft. The tests were part of Saab's 2006 contract with Poland for the delivery of RBS15 Mk3 missiles, and their installation on *Orkan*-class ships. The tests, with the lead-vessel-in-class *Orkan*, validated all the ship's interfaces with the necessary power, combat management and navigation systems. The tests included a simulated missile firing exercise, and concluded with sea trials when the ship carried its full complement of eight missiles. The Polish Navy have now demonstrated their ability to equip and operate these vessels with their maximum missile load. "Throughout all the tests, the level of co-operation with the Polish Navy and Polish industry has been excellent. This achievement is further testament to our long term commitment to the Polish Navy and local industry and we believe there will be further opportunities such as Poland's upcoming surface vessel requirements", said Jason Howard, head of Naval Segment CEE, Market Area Europe and Greater Middle East at Saab. The two remaining *Orkan*-class ships: *Piorun* and *Grom*, are scheduled to undergo similar systems tests later in 2015.

RBS15

A26 and *Gotland*-class submarine sensor systems

Saab has received an order from the Swedish Defence Material Administration (FMV) for new sensor systems for two A26-type and two *Gotland*-class submarines, the contract valued at SEK 420 million. This order covers Swedish armed forces' underwater capabilities over the period 2015-2024. However, neither a production order for A26-type nor a modification order for *Gotland*-class has been received for the submarines. These systems will be provided to Saab by other suppliers which have long lead-times for delivery, to allow the FMV to progress with its plans for the A26 next-generation submarine programme.

FREMM *Provence* multi-mission frigate in sea trials

The FREMM *Provence,* built for the French Navy by DCNS, has completed its first sea trials on conducted off the Brittany coast, the main objective being to test performance of the vessel's propulsion and navigation systems. In a second phase, the trials will be focused on CODLOG (COmbined Diesel eLectric Or Gas) hybrid system, with highly efficient propulsion system allows the FREMM to sail silently at low speed using the electric motors – or to reach speeds in excess of 27 knots thanks to the vessel's gas turbine.

Thales to develop Sea Fire 500

Thales is developing its new Sea Fire 500 multifunction naval radar. With a solid-state four-panel phased-array antenna, designed for large surface combatants, this new radar concept is the culmination of three years of advanced research into new radar technologies and architectures, conducted with the support from the French defence procurement agency (DGA). Sea Fire 500 "will be effective in roles ranging from ship self-defence to extended air defence, providing protection from asymmetric threats such as UAVs as well as emerging threats such as anti-ship ballistic missiles, even in heavily jammed environments and the complex conditions of the littoral." With the combination of its four fully solid-state active fixed arrays, each offering higher power, beam steering agility and 90° coverage, the radar will provide significantly higher detection and tracking performance with continuous 360° coverage in azimuth and 90° coverage in elevation.

Scorpion contract awarded to Nexter, RTD and Thales

During the visit to the 27th Mountain Infantry Brigade at Varces (Isère), Jean-Yves Le Drian, Minister of Defence, handed over EBMR (Armoured Multi-roles vehicles) to the CEOs of the GME (consortium) formed by the French companies Nexter Systems, Renault Trucks Defence and Thales.

Under the EBMR contract, the Multi-Role Armoured Vehicle Griffon and Reconnaissance and Combat Armoured Vehicle Jaguar will replace the VAB, and the AMX10RC, the ERC Sagaie and the VAB Hot used extensively by the French Army in all theatres of operation for thirty years. The contract covers all phases of an armament programme, from development to unit logistical support through the qualification and production of systems. The GME is committed to the integral performance of the equipment in the long term as well as the operational availability of vehicles in service.

Eyes over the Ocean

Northrop Grumman's E-2D Advanced Hawkeye

Northrop Grumman's E-2D Advanced Hawkeye is well-positioned to support India's present and evolving requirements of airborne early warning and control (AEW&C) capabilities.

Built on a legacy of providing uncompromising airborne early warning and control capability, the Hawkeye aircraft was designed to provide the enhanced capabilities required to meet emerging threats and improved mission effectiveness from both shore bases as well as from the decks of today's modern aircraft carriers. The Advanced Hawkeye's upgraded systems and capabilities provide long-range detection and tracking

of very small and maneuverable targets and provide a seamless stream of information between the key assets of the fleet.

Features include completely redesigned aircraft systems, the state-of-the-art AN/APY-9 radar and a new glass cockpit. All E-2Ds are newly manufactured aircraft based on a proven airframe design, which is capable of both long-range shore operations, and carrier-based operations. Evolving the mission sensors with new technologies and capabilities affordably brought a new, state-of-the-art system without having the challenge of designing a new platform.

'see' a greater number of targets at much greater distances than currently fielded radar systems – as well as new avionics and a glass cockpit.

The APY-9 was specifically designed for Cruise Missile Defence and to protect the US Navy's most important asset – the Carrier Battle Group. This state-of-the-art radar provides the most technologically advanced airborne early warning and command and control capability in the world, with the ability to collect data and supply information to naval and joint forces well ahead of engagement.

As new threats have emerged over the past fifty years, the E-2 has undergone several configuration upgrades to provide an enhanced situational awareness and improved mission effectiveness all nations require for today's missions as well as those of tomorrow. The E-2D is a uniquely integrated system for the defence of any nation and highly interoperable with coalition partners. With its network-centric capability, the E-2D will help nations with maritime surveillance, homeland security and associated crises as well as combat operations.

First E-2D landing on USS Truman

As the only US Department of Defence designed, tested and in-production AEW&C platform, the E-2D Advanced Hawkeye has undergone a significant transformation from previous E-2 models, resulting in revolutionary capabilities. This includes the new, more powerful AN/APY-9 radar system, exclusive to the E-2D Advanced Hawkeye, which represents a two-generational leap in radar technology and allows the warfighter to

With its structurally distinctive design – a rotating rotodome and four vertical stabilizer tail configuration – the E-2D Advanced Hawkeye provides unprecedented, continuous 360-degree air and surface surveillance to the war fighter, allowing the operator to focus on select areas of interest, vastly improving situational awareness. The new rotodome allows for three modes of operation including an electronically scanned mode.

The new glass cockpit features three 17-inch liquid crystal display panels, providing the flexibility to display a full tactical radar display in the cockpit, allowing one of the cockpit crew to act as a 'tactical fourth operator'.

In partnership with the US Navy, Northrop Grumman has a continued growth path and technology insertion plan for the E-2D, as has been done with the current E-2C fleet. Several key areas of

E-2D Aerial Refueling Preliminary Design Review

As the US continues to focus on the Asia-Pacific region, extended range of the E-2D Advanced Hawkeye can provide enhanced maritime security required by the vast geography of the Asia-Pacific region, for both the US and its allies.

Northrop Grumman and the US Navy have successfully conducted the preliminary design review (PDR) for its E-2D Advanced Hawkeye Aerial Refueling system. Completion of this critical milestone allows the programme to proceed to its critical design review, moving closer to manufacturing the system and installing it on new production E-2Ds as well as retrofitting it onto E-2Ds that are currently operating in the Navy fleet.

Under a $226.7 million engineering, manufacturing and development contract awarded in 2013, Northrop Grumman is designing several system upgrades necessary to accommodate an aerial refueling capability. These include new seats to enhance pilot field-of-view and decrease crew fatigue; formation lights for better visualization and air space orientation; and enhanced software in the aircraft's flight control system to assist the pilots with aircraft handling qualities when refueling.

The Navy's E-2D programme is for 75 aircraft and there are currently 62 E-2Cs operating in the Navy's fleet, with an additional 28 E-2Cs operating in the militaries of Egypt, France, Japan and Taiwan.

future focus include: in-flight refuelling, extended range fuel tanks, and continued evolution of sensors and systems.

Initial Operational Test and Evaluation was conducted by the US Navy during 2012 and Initial Operational Capability with the US Navy fleet occurred in October 2014. The E-2D programme continues to meet, or exceed, all technical and program requirements and flight testing produced excellent results with the E-2D systems, including long-range radar detection. As of November 2014, Northrop Grumman has delivered 16 newly manufactured E-2D Advanced Hawkeyes to the US Navy.

In June 2014, the US Navy awarded Northrop Grumman a $3.6 billion multiyear contract for 25 new E-2D Advanced Hawkeye aircraft, bringing the total number of aircraft on contract to 50. A multiyear procurement of additional E-2Ds takes advantage of efficient, stable production lines at both Northrop Grumman and its suppliers, and generates significant cost savings for the customer. The Navy plans to procure a total of 75 aircraft with continuous deliveries extending into 2026.

Indian Navy's RFI

In 2010, Northrop Grumman responded to a formal Indian Navy Request for Information on four carrier-based airborne early warning and control aircraft with technical information on the E-2D Advanced Hawkeye. As the only AEW platform designed specifically to meet the demanding environment of carrier operations, the E-2D Advanced Hawkeye is ideally suited for the Indian Navy's requirements.

With more than 4,700 miles of coastline, the Indian Navy has to shoulder a massive responsibility and needs robust intelligence, surveillance and reconnaissance capability to ensure the security and stability of its maritime frontiers.

"Northrop Grumman is proud of the successful relationships it has built, and continues to build, around the world." In early 2012, the US government announced a sharper US foreign policy focus on the Asia-Pacific region. This shift provides the opportunity to strengthen strategic, collaborative relationships with United States allies around the globe.

The company's strong relationship with India goes back many decades and is built on a legacy of trust and performance. Its range of industry-leading capabilities, products and services are available to international markets and currently with customers in 25 nations. Northrop Grumman is fully prepared to meet the current and future requirements of the Indian armed forces by providing India with advanced technology and capabilities while demonstrating the value of performance.

Commodore Gyanu Sharma, IN (retd)

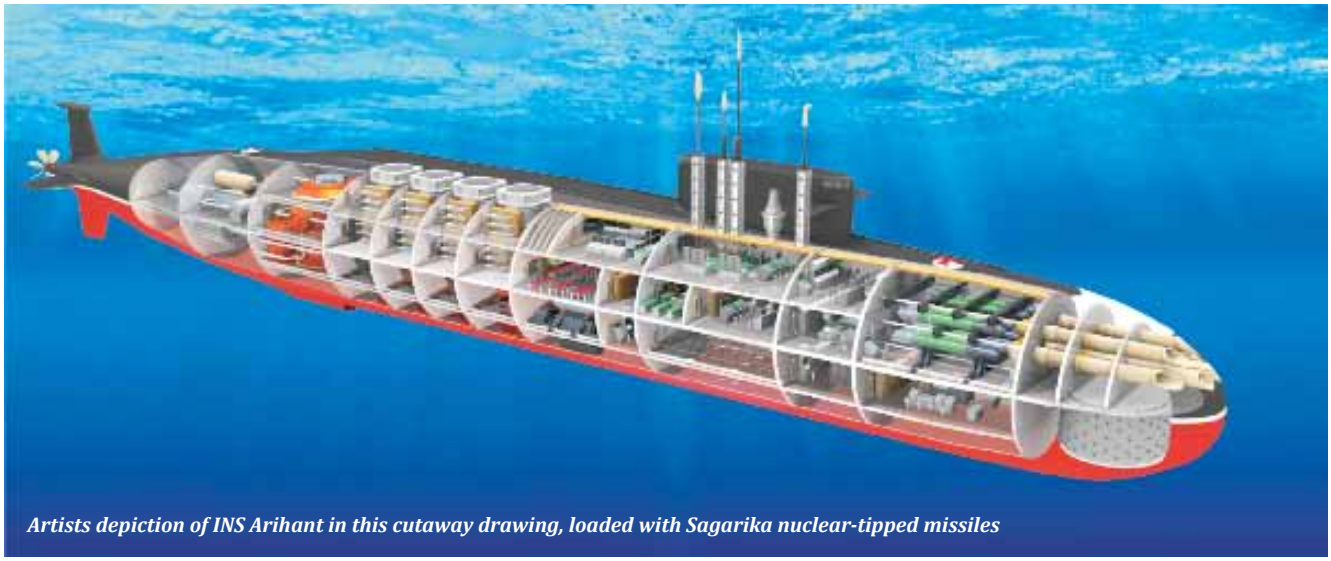
Arihant Ahoy !

Vice Admiral Arun Kumar Singh's update on the Indian Navy's first indigenous nuclear-powered submarine.

Chance shot of INS Arihant taken by an observer as she leaves Visakhapatnam port

The port city of Visakhapatnam (commonly referred to as Vizag by seafarers), is also known as India's 'city of destiny' and will someday be also known as 'submarine city'. Vizag holds the distinction of being the home port of India's first conventional submarines (purchased from the USSR) and nuclear submarines (tactical SSN types leased from the USSR), and the Navy's first submarine base (INS *Virbahu*), as also the submarine training establishment (INS *Satavahana*).

On the evening of 15 December 2014, according to media reports, India's first indigenously designed and built strategic nuclear submarine (SSBN), the 6000 tonne INS *Arihant* sailed out of Vizag harbour for her first sea trials sortie. The internet has indicated that design work for the *Arihant* began soon after the 1974 Pokhran nuclear device was tested by India, and construction work began in 1998. The submarine was publicly launched 11 years later, on 26 July 2009. Post launch, the *Arihant* took another 5½ years to complete harbour trials and then commenced sea trials on 15 December 2014.



Artists depiction of INS Arihant in this cutaway drawing, loaded with Sagarika nuclear-tipped missiles

Conventional submarines are virtually impossible to detect when they operate underwater for brief periods, being propelled by electric motors getting power from huge lead acid batteries. Unfortunately, these conventional submarines become vulnerable when they expose themselves every 18 to 24 hours for charging their batteries by air-breathing diesel generators. A nuclear powered submarine can remain submerged for months and hence can avoid detection.

The nuclear submarine INS Chakra leased from Russia, berthed at the naval base Visakhapatnam

After the dropping of atom bombs on Hiroshima and Nagasaki in 1945, American scientists began work to harness the power of the atom to propel submarines underwater, knowing fully well that nuclear power would give them higher sustained underwater endurance (3 months submerged) and very high sustained speeds of 20 to 30 knots as against 3 to 4 knots of conventional subs). Nuclear power makes a submarine almost invulnerable to enemy counteraction and provides a nation with global blue water reach for both tactical operations (SSN) and strategic deterrence (SSBN) tasks.

On 17 January, 1955, the world's first nuclear submarine the 3500 tonne *Nautilus* (SSN) of the US Navy, made the historic signal "Underway on nuclear power". The SSN provided the USA with a global capability to destroy enemy ships and submarines. The Americans followed up this success by commissioning the world's first SSBN (the 6000–tonne USS *George Washington*) on 30 December, 1959. Armed with 16 nuclear-tipped Polaris A1 'Submarine Launched Ballastic Missiles' (SLBMs), each having a range of 2500 kilometres, the new SSBN provided the USA with an invulnerable strategic second strike capability against the USSR, which was its primary nuclear armed adversary.

Today, SSBNs of five nations carry nuclear-tipped SLBMs which have ranges varying from 7000 kms (China) to over 10000 kms (Russia, France, UK and USA). India will soon join this elite club once the *Arihant* and its SLBMs complete sea trials and more SSBNs are built in India (it should be noted that for a viable sea based deterrent, at least four SSBNs are needed, so that one can be on underwater sea patrol at any given time). Media reports do indicate that an additional two to three *Arihant*-class SSBNs are presently under construction.

It may be noted that the US nuclear subs, viz the *Nautilus* (SSN) and *George Washington* (SSBN) took only three years from the time construction commenced to the time of starting sea trials. Today modern sophisticated SSNs and SSBNs, take 5 to 7 years from the date of starting construction to the date of commencement of sea trials. The *Arihant* has taken over 16 years, and India's new Defence Minister needs to ensure that future SSBNs (and SSNs) will be ready in 7 years from starting of construction to beginning of sea trials.

The *Arihant* and her pioneering crew will now spend the next 12 months or so carrying out trials at sea, which will culminate in weapon trials and include actual firings of two types of indigenous SLBMs which can carry nuclear warheads. As per media reports, these are the 700 km range K15 and the over 3000 km range K4. The internet also mentions that DRDO is planning a 5000 kms range SLBM designated the K5.

While the *Arihant*-class SSBNs are a good beginning, our naval planners, designers and scientists need to commence work on a new generation of larger SSBNs with improved stealth characterises, more powerful reactors and longer range SLBMs (over 5000 kms), which will simultaneously cover the whole of China and Pakistan. The internet also indicates that six SSNs are planned to be built in India, and if this is indeed true, hopefully India's Defence Minister will ensure that a second nuclear submarine production line is opened up for timely construction of SSNs .

Post sea trials, in 2015 Prime Minister Modi can look forward to commissioning the INS *Arihant* as a combat ready unit of the Navy, and she will hopefully participate in the International Fleet Review (IFR) planned to be held at Vizag in February 2016, where warships from many foreign navies and coast guards will participate, with the emerging nuclear Indian Navy as the host.

Vice Admiral Arun Kumar Singh was trained in the former USSR on nuclear submarines and missiles. He retired in 2007 as Commander-in-Chief of the Eastern Naval Command

Need of the Times !

Lead and Execute

At the book launch at Bangalore on 18 December 2014 : (left to right) the author, Yogesh Kumar, Chairman HAL Dr RK Tyagi, Director (D&D), Chairman designate HAL T Suvarna Raju, President SAS Pushpindar Singh.

India's first foray into the 'art' of developing and flying an indigenously-designed fighter project was when the HF-24 Marut first flew in June 1961. It was after another forty years that the next Indian-designed fighter aircraft, the Tejas Light Combat Aircraft (LCA) made its first flight, in January 2001 !

Also, the first Indian-designed jet trainer aircraft HJT-16 Kiran made its first flight in December 1964. Thirty-nine years later, the HJT-36 Sitara intermediate jet trainer made its first flight in March 2003. The Indian aircraft industry is now 74 years of age and the first Indian designed trainer, the HT-2, first flew in December 1951 at a time when two wheelers and cars had not made their manufacturing debut in India.

Books written by aviation enthusiasts in India are far and few between and books detailing the design and development of aircraft projects are a rarity. So it was a refreshing surprise to read a different book *Lead and Execute – The Art of Managing Large Scale Projects* written by Yogesh Kumar, a former Director (LCA) Hindustan Aeronautics Limited. He has more than four decades of experience in Design and Development projects and headed the Design organisation in HAL when some critical projects like the LCA, IJT and others were in full steam.

This interesting book is a unique attempt to describe, from first hand experience, the challenges of managing complex aviation projects. Specifically, it describes Yogesh Kumar's own experience when leading the LCA, IJT and Jaguar DARIN II programmes. The LCA was an incredibly complex project. One of the largest R&D projects undertaken, marrying state of the art technologies from more than forty diversified disciplines executed at a hundred different work centres ! How does one manage such a project in a scenario where there has been a massive gap between the last such? With obsolete test and development infrastructure and where the best engineering talent is fascinated by the magic lure of 'Information Technology' ?

Devasis Chowdhury in interaction with Yogesh Kumar on stage after the book launch

Yogesh Kumar's book asserts that Project-mode management is a unique path they charted wherein Technology, Communication, Human Resources, Cost and Time frame, Data, Documentation and Risk management streams need to be linked, and to be "passionately managed". The LCA had challenges in its organisational structure whose boundaries needed synergetic working. Integrating the detailed design and validating design by testing in first time test facilities like the Iron Bird, the brake dynamometer, environmental control systems and many other non existent test setups leading to the taxi trials and first flight makes for a fascinating chronicle.

Yogesh Kumar flanked by Dr. K Tamilmani, DG (Aerospace) DRDO and Dr. AK Ghosh, PD AMCA at ADA (right)

The IJT had set up a record of sorts where from first metal cut to first flight was done in less than two years, is also described in this book. The execution of the project is described in detail with numerous charts, graphs and activity ellipses for overall review.

The Jaguar DARIN II Upgrade was a different project undertaken on an existing platform and had its own challenges.

This reviewer had an opportunity to discuss the book at the release function at HAL's Management Academy, Bangalore on 18 December 2014. What emerges is that Yogesh Kumar felt that he needed to share his four decade long experience managing these projects of various complexities. The clear message is: "treat everything as a project requiring will power, passion and killer instinct". Many of our national projects suffer from a lack of ownership. The book poses a question - can we treat a project and its products as animated beings, which get hurt if not treated properly?

For the reader, the book has many facets on how to face, respect and operate within a system. How does one navigate the perplexing limbo between design, conception and execution? Complex problems suffer from maddening deadlines and confusing project priorities.

This book is an exciting ride through the science involved in challenging technical situations and will reassure - and enlighten - the intrepid reader who passionately follows the adventure of designing and giving shape to an Indian-designed aviation product.

Devasis Chowdhury

The reviewer is an aviation enthusiast who worked in the aviation industry and retired as the Chairman Mishra Dhatu Nigam

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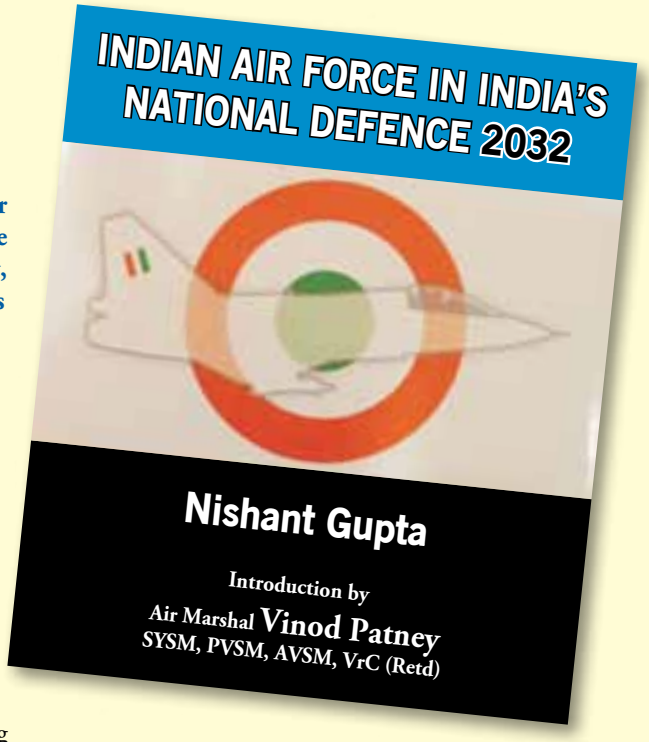


Group Captain Ashok K Chordia (retd), former Assistant Director of Operations (Para) at Air HQ and presently Senior Fellow at the Centre for Air Power Studies in New Delhi reviews the history, transformation and future imperatives of the Indian Air Force, as authored by Wing Commander Nishant Gupta, IAF.

To begin with, Wing Commander Nishant Gupta credits the British for creating the IAF as an independent service from the very beginning rather than treating it as an arm of the Indian Army. At the same time, he reflects that the British deliberately kept the IAF poorly equipped and inadequately staffed.

Post independence, the Indian leadership focused on diplomatic pursuits and sought to attain a high moral ground in international relations overlooking the desirable growth of the military. India pursued a policy of peaceful coexistence and non-alignment and took a well-considered view to lessen the role of military in the geopolitics of the region. This is amply evident in the fact that India has never initiated a war; only responded to external aggression. This mind-set, and the matching approach of the political leadership supported by the bureaucracy, led to a neglect of the defence capabilities of the country. Wing Commander Gupta disapproves of such a policy that led to difficult times for the Indian armed forces, the IAF included. According to him, a foreign policy that relies entirely on diplomatic efforts to pursue national interests, without matching defence preparedness, is *fundamentally flawed.*

In a nutshell, Nishant narrates the 81-year history of the Indian Air Force from its inception until the present day. Interesting bits of information are sure to keep the reader engrossed. Nishant cites how with each employment experience the leadership increasingly felt the requirement of strengthening the IAF. But the process remained excruciatingly slow.

Nishant gives an absorbing yet brief account of the rise of the IAF from the very humble beginnings to being the fourth largest air force in the world. But like many other authors who had tread the same path before him, Nishant rues the non-availability of records in the open domain to pursue a deeper study of this nature.

Notwithstanding the academic hurdles, Nishant encapsulates the saga of the Indian Air Force in an interesting and informative manner. While analysing the past and the present, he suggests a path for the IAF to be a formidable force by the year 2032, when it will be a hundred years old.He analyses the geopolitics of the region, the war scenario and the capabilities of the neighbours, China and Pakistan. He opines that India must concentrate on its economic development while being prepared for a two front war with eyes on the insurgency and growing Naxal Movement.

In times to come, the country will face numerous security challenges, traditional as well as unprecedented, which in turn will place increasingly pressing demands on the IAF. To meet such diverse requirements, the IAF is required to be an inherently flexible multi-spectrum force; flexibility and best exploitation of the limitedresources should therefore be the bedrock of the acquisition, training and employment philosophy of the IAF, infers the author.

India is a major importer of defence equipment; to sustain the defence expenditure, a major part of our defence needs must be met indigenously. Among other policy recommendations, cooperation in R&D and collaboration in manufacturing need to be encouraged to turn India into an exporter. Recent announcements regarding increase in FDI limits in defence sector, in line with author's recommendations, underscores his understanding of the subject.

Regarding transformation of the IAF, the author suggests that articulation of formal documents like the national security doctrine, objectives, strategy and policy is essential to maximise the potential of the armed forces. For accomplishing military transformation initiative, integrated efforts of political leadership, bureaucrats, scientific community and military professionals is a prerequisite. And for achieving this,the Higher Defence Organisation(HDO) needs to be reformed at all the three levels –the highest level defining the political control over military; the middle level integrating political, bureaucratic and military wisdom to drive defence planning and policy; and the third level synergising the combined military potential of the armed forces.

In his introduction to the book, Air Marshal Vinod Patney, Director General, Centre for Air Power Studies gives credit to the pioneers for laying the foundation of an imposing Air Force. He retraces the seasoning of the IAF over the years, through the thick and thin of wars and warlike situations, including the *Military Operations Other Than War* (MOOTW). Air Superiority, according to him, is a classical desideratum; only the ways and means of vying and achieving it could vary. Considering the distinct and diverse core competencies of the three services, he stresses the essential requirement of joint planning. He re-iterates the importance of the human resource in achieving the organisational goals.

Published by Knowledge World, 2014, 240 pages

REMEMBERING PARVEZ

The life and times of Air Commodore Parvez Hamilton Khokhar

For the *Vayu Aerospace & Defence Review* fraternity, remembering Air Commodore Parvez (Hamilton) Khokhar is not an abstraction, but an intense and palpable feeling of deprivation. Suddenly and tragically, we are deprived of his company at *Vayu*, when during aviation-related brainstorming sessions, post retirement from the IAF, he was engaged in an advisory role with various leading aviation organisations. Impeccably dressed and exuding aplomb and confidence suffused with excellent communication skills, he would enlighten everyone around about the intricacies and dynamics of extreme fighter flying. A test pilot for decades, he evinced maturity and wisdom that follow ultimate accomplishment in any field of human endeavour. He was also a dear friend and now sadly missed by every member of the editorial team.

Air Commodore Khokhar's precious life was shockingly snuffed out by a criminal act during the night of 23-24 November 2014 at his Smiley Greens residence in suburban Bangalore.

Born at Batala in the Punjab in an Army family – his father was a Lt Colonel – Parvez was commissioned into the fighter stream of the Indian Air Force in 1968 and in the years that followed, proved his mettle as a fighter pilot, becoming an A-2 Category Qualified Flying Instructor (QFI) and flying several operational missions in the December 1971 war. Later, on completion of the Production Test Pilots Course at ASTE, he graduated as an Experimental Test Pilot in 1977-78.

Flt Lt Parvez Khokhar with Gnat during the December 1971 War

In 1982, Parvez was awarded the Vayu Sena Medal for his "professional competence, leadership capabilities and devotion to duty of an exceptional order." The official citation for this honour mentions his employment on active duties with the Flight Test Squadron at the Aircraft System Testing Establishment (ASTE); being detailed as Project Pilot for the HPT-32 piston engine basic trainer aircraft under development at HAL. He took active part in prototype testing of this aircraft including high risk tests such as stalling, spinning and engine air starts. Besides, he carried out a number of service trials on the HF-24 Marut, Ajeet, Iskra and MiG-21 aircraft.

Air Commodore Khokhar flew some 60 types of aircraft "without a single avoidable accident." He served as Station Commander, AF Station Bhuj, as Air-II at Central Air Command, as Commandant ASTE and was at the Air Force Academy. Before retiring from the IAF in 2003, he was Project Director at ADA for development of the Tejas LCA. An extraordinary assignment was his posting as Air Adviser with the Indian High Commission in Pakistan.

A keen writer, Air Commodore wrote several articles on various facets of air power, many of which were published in the *Vayu*. Development and production of the LCA was the subject of immense importance to him. He was a keen supporter of the programme and as he once wrote, "The Tejas Mk.I is far superior to the MiG-21. In key respects, it is better than even the Mirage 2000. The Tejas Mk.I should enter the IAF's combat fleet in large numbers. This would allow the Air Force to retire the MiG-21 fleet soon". His views reflected his courage of conviction in the face of contrary projections by other analysts. However, he warned against too much optimism on the proposed LCA Mk.II which programme he felt is fraught with very many uncertainties.

Air Cmde Khokhar at an Air Show

The *Vayu* team remembers him for his sterling qualities of head and heart, his valuable association with us. Above all, the indelible image that lingers in the mind is that of an avid aviator who served as Director National Flight Test Centre in support of the LCA programme and overall flew 5000 hours on 62 different aircraft types including Soviet-origin fighters ranging from the bisonic MiG-21 to the trisonic MiG-25R.

The sonnet 'High Flight' by John Gillespie Magee, Jr is certainly apt when remembering Parvez.

Oh! I have slipped the surly bonds of Earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth
Of sun-split clouds, — and done a hundred things
You have not dreamed of — wheeled and soared and swung
High in the sunlit silence. Hov'ring there,
I've chased the shouting wind along, and flung
My eager craft through footless halls of air. . . .

Up, up the long, delirious burning blue
I've topped the wind-swept heights with easy grace
Where never lark, or ever eagle flew —
And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space,
Put out my hand, and touched the face of God.

Gp Capt JC Malik (retd)

Tribute to a Legend

Wing Commander Inder Mohan Chopra, former Chairman HAL, and earlier Chief Test Pilot HAL, pays tribute to his good friend, the legendary test pilot Group Captain Kapil Bhargava who passed away on 17 December 2014 at Bangalore

My friend Kapil is no more. It was extremely sad and I felt tremendous grief for someone I knew for over 60 years.

I first met Kapil in Jodhpur as a cadet in 1950 when I joined the 55th Course, while Kapil was of the 53rd course. Those days, odd number courses were trained at No. 2 AFA Jodhpur and even number courses at No.1 AFA Ambala. Juniors were in awe of the seniors so interaction was generally confined to salutations. Kapil was commissioned on 14 October 1950 and received the Flying Trophy in his course.

I next met Kapil in England in January 1957 when Bobby Dey (later Air Marshal PK Dey) and I arrived to join the 16th Empire Test Pilots Course (ETPS) at Farnborough. Kapil and Sudhakaran had just graduated from the 15th course. Sudhakaran was a brilliant officer and flier and recipient of the Sword of Honour. Unfortunately his career was cut short due to the fatal crash in a Gnat doing hot weather trials at Kanpur. Early in 1950, Kapil completed PAI (Pilot Attack Instructors) course in the UK.

Thereafter I met up with Kapil in Egypt. He had been deputed to Factory 36 located at Helwan about 35 kms from Cairo which was developing the HA-300 supersonic fighter for the Egyptian Air Force by a design team headed by the great Willy Messerschmitt. I was deputed to Factory 135 located at the same place which was developing E-300 engines for the HA-300. The team was led by Dr. Ferdinand Brandner (an Austrian) who made several turboprop engines in Russia after WWII. The engine was to be fitted on the right side of the aircraft while leaving the Orpheus on the left.

An HF-24 was modified for this purpose and positioned at Helwan for the E-300 development, and designated as the HF-24 Mk.1BX. There was also some thinking of using this engine for the HF-24 which needed a more powerful engine : India would have liked the Egyptian Air Force to use the aircraft with this engine. I was in Egypt for about three years and Kapil was there longer and I got to know him well. We discussed almost daily the British/US military aircraft and engine specifications used for clearance of aviation systems. I realised then how well he understood fight testing and was incisive in failure analysis. It was an education for me.

We made a good team in facing the German, Austrian and Swiss engineers and were very ably assisted by Gp Capt CS Naik (later Air Marshal) who led the HAL team maintaining the HF-24. Kapil mostly handled the HA-300 issues. Willy Messerschmitt lived in Spain and occasionally came to Helwan to review the HA-300 project. Kapil was forthright with his comments on the disregard of safety aspects and Meserschmitt had to reluctantly agree to make the changes suggested.

Flight Cadet Kapil Bhargava before commissioning

Gp Capt Kapil Bhargava at his home in Bangalore

I think three prototypes of the HA-300 were constructed and at least two aircraft were fitted with Orpheus engines as the E-300 was not ready. I think the first prototype (V1) was flown by Kapil sometime in mid-1964 and he made the first flight with the E-300 engine of HA-300 I think in 1970. I flew 140 development flights on the Mk.1BX. Thanks to the goodwill of Kapil, I got to fly 3 flights on the HA-300 powered by the Orpheus in 1968. As a quid pro quo Kapil flew a few flights on the HF-24 Mk.1BX. Both the HA-300 and E-300 projects were eventually closed down owing to lack of funds after the Arab- Israeli war of 1967.

When we met in England, Kapil's wife Mohini was with him and Mala, their first child, was still a small baby. While in Egypt I often met Kapil and Mohini socially and our friendship prospered. We had many get togethers especially on New Year's eve and Mohini provided great support and the home was full of brightness and joy. Mala, Kishore and Meena were growing up in the right environment. The children are all now in successful careers, Mala working for a reputed magazine *Business World*, Kishore is an adviser in IT with important clients and Meena is in commercial business.

Later, Kapil was Station Commander Jodhpur. He was not promoted to Air Commodore rank and immediately put in his papers for retirement, leaving the service on 16 November, 1976. I was shocked at this decision of the top brass of IAF. They lost an invaluable *GEM*. His positives outweighed the negatives if any he may have had. He had the courage of conviction to leave the IAF which he had served so well with commitment and boldness. He was disappointed but perhaps not bitter if his demeanor was any indication and this is the hall mark of an individual with inner strength.

After a stint with a commercial firm he joined HAL as Executive Director, Flight Safety. Air Chief Marshal L M Katre who was then Chairman of HAL felt Kapil was the most suitable person to help investigations of accidents cogently and honestly identify responsibility. Kapil was extremely efficient in this job and was praised by all his support staff. I had given up test flying in July 1980 and was then in management and met Kapil on several occasions in connection with accidents. Kapil was the recipient of his first Vayu Sena Medal in 1962, as test pilot for the maiden flight of the first Avro 748 manufactured at the BRD, Kanpur.

Kapil was one of those with great skill in test flying backed with knowledge of design requirements. He excelled in his job from a cadet to an executive and has raised the benchmark for flight testing to great heights. The young flight testers who follow will have to exhibit similar commitment to get near it. I am delighted that ASTE conferred on him the first 'Life Time Achievement in Flight Testing' Award.

Kapil Bhargava in cockpit of the HA-300 fighter, displayed at the Deutsches Museum near Munich in Germany

He settled in Bangalore as I did too, after retirement from HAL. We would meet on several occasions at official and social functions and I was glad to keep in touch with him. Later on when my mobility became limited, we spoke on the phone for 15-20 minutes often and it was always a stimulating experience. We discussed aviation, politics, economic policies, and problems facing the country. We agreed on most issues but disagreed on some.

Kapil was a repository of knowledge and when finding some matter on Internet not easy, I would called him. He could easily give advice on computers, mobile phones, IT etc. If he did not have the answer, he had the humility to agree to try and get it. It was my great privilege and honour to have his friendship and I am sorely going to miss him. I would sum up Kapil Bhargava the Legend in six words :

"He was a True Human Being"

Splendidly preserved is this HAL HF-24 Marut, presented by then Air Chief Marshal LM Katre to the Deutsches Museum at Munich

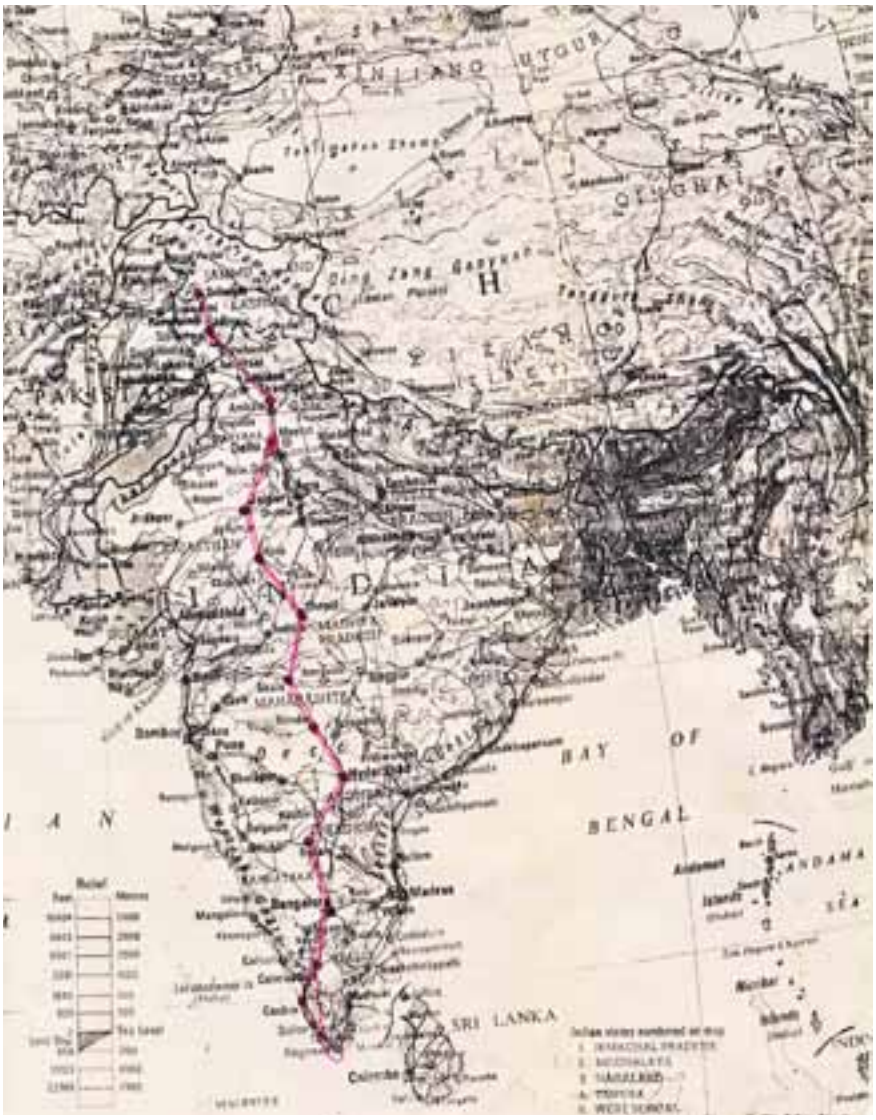
Freedom Flight

HAL Pushpak flies by the Aircraft & Systems Testing Establishment (ASTE) at Bangalore, which Air Vice Marshal Ajit Singh Lamba had once commanded. In this iconic picture, 14 aircraft types are displayed on the tarmac

In 1997, as part of the celebrations marking Golden Jubilee of India's Independence, a flight in a light aircraft from Kanyakumari to Srinagar was proposed. A Pushpak aircraft belonging to the Indian Institute of Science at Bangalore, under the maintenance and operational control of the Centre for Air Borne Systems (CABS) was the aircraft of choice. The project was approved by Dr K Ramchand, Director at CABS and launched under the patronage of the Bangalore branch of the Aeronautical Society of India. The object of the flight was to spread the message of air-mindedness and air adventure amongst the country's youth and also to mark the contribution of HAL, who had designed and developed the aircraft forty years prior.

The Aircraft

The HAL HUL-26 Pushpak is a two-seat, strut braced, high-wing monoplane with a fixed undercarriage, and powered by a single continental C-90-8F engine, driving a fixed pitch propeller. The aircraft flew for the first time on 26 September, 1958 and was subsequently acquired by a number of flying clubs in the country. The cruising speed of the aircraft is 60 knots, its SL rate of climb 350 ft/min under ISA + 10°C conditions, and service ceiling about 11,000 ft. The maximum AUW is 650kg, while a small storage space is available behind the pilot's seat. Certified under 'normal' category, aerobatics, violent manoeuvres and spinning are prohibited! The Pushpak is cleared to fly in Day/VFR conditions only. Flight



Kanyakumari to Srinagar: traversing the sub continent

FREEDOM FLIGHT : The Flight Plan

Date	Route	Take-off Time	Landing Time
07 Nov. 97	Bangalore - Coimbatore Coimbctore - Trivandrum	11.00 14.00	13.00 16.30
08 Nov. 97	TVM-O' fly K'kumari-Cochin Cochin - Coimbatore Coimbatore - Bangalore	08.00 13.00 15.00	11.00 14.20 17.00
09 Nov. 97	Bangalore - Bellary Bellary - Hyderabad (B'pet)	09.00 13.00	11.20 15.45
10 Nov. 97	Hyderabad - Nanded Nanded - Akola Akola - Bhopal	08.00 12.00 15.00	10.00 13.30 17.35
11 Nov. 97	Bhopal - Kota Kota - Jaipur Jaipur - Delhi (Safdarjung)	09.00 12.00 15.00	11.20 13.40 17.10
13 Nov. 97	Delhi - Chandigarh	11.00	13.20
14 Nov. 97	C'garh-O'fly P'kot - Jammu Jammu - Srinagar	09.00 14.00	11.40 15.45
15 Nov. 97	Srinagar - Jammu Jammu-O'fly P'kot - C'garh	09.00 12.00	10.40 14.40
16 Nov. 97	Chandigarh - Delhi (Hindon) Delhi - Jaipur	09.00 13.00	11.40 15.20
17 Nov. 97	Jaipur - Kota Kota - Bhopal	09.00 12.00	11.40 14.40
18 Nov. 97	Bhopal - Akola Akola - Nanded Nanded - Hyderabad	08.00 13.00 15.30	10.35 14.30 17.30
19 Nov. 97	Hyderabad - Bellary Belaary - Bangalore	09.00 13.00	11.45 14.50

instrumentation is quite rudimentary and there is no altitude indication in the cockpit. Thus, it has to fly with reference to outside features only. Total fuel capacity, including an auxiliary tank, is 85 litres, 100 octane LL, which gives a safe endurance of about 3.5 hours.

For this flight, the aircraft (VT-DWA) was fitted with a GPS indigenously developed by CABS and produced by ASPL, Bangalore. We carried an additional handheld Garmin GPS-195. The aircraft was repainted in silver grey with national tricolour and markings of HAL and AeSI.

The Journey

Freedom Flight was launched with great fanfare on 7 November 1997. A flag-off ceremony was conducted, and attended by nearly 2,000 people, the flight flagged off by the Governor of Karnataka, Khurshed Alam Khan. The Pushpak took off at 1100 hrs and was escorted by two Chetak helicopters flown by HAL test pilots up to a distance of around 5km. A scientist at CABS, S Ramanathan was my co-pilot, but for the Coimbatore-Trivandrum-Cochin-Bangalore stretch, I was accompanied by a flight test engineer from ADA, Wg Cdr Raveendran.

Our first landing was Coimbatore. Halfway between Bangalore and Coimbatore, there are hills with average heights of around 4-5,000ft. I selected flight level 80 to avoid turbulence and some low and medium clouds. Cruising at 50 KIAS, we got a ground speed of about 80 knots, arriving at Coimbatore slightly ahead of schedule. While the flight itself was uneventful, a small reception had been organised by the local Air Force establishment where the students of an engineering college and NCC cadets had been invited. After a brief halt we took off for Trivandrum.

The flight to Trivandrum proved more interesting. South of Coimbatore, the Anaimalai Hills extend up to about 80 nm with certain peaks at 8 and 9,000ft. I selected flight level 105. We were over layers of alto-stratus. As the flight progressed, the cloud amount and height increased, eventually forcing us to cruise at 11,000ft over a complete blanket of cloud a mere hundred feet below us. The aircraft refused to climb beyond that height. We heaved a sigh of relief as the cloud amount reduced and we got glimpses of the ground below as we cleared the hill range and approached the Arabian Sea coast. The so-called withdrawal of the North-East monsoon was obviously not complete as we were to find greater evidence of it the next day. On landing at Trivandrum, we were received by the local Mayor and members of the AeSI.

On the following morning, 8 November 1997, our original plan was to take-off from Trivandrum, fly over Kanyakumari (there is no airfield at Kanyakumari) and proceed to Cochin. The total distance was 180 nm. This would have been manageable in favourable flight conditions. However, owing to prevailing bad weather, we decided to return to Trivandrum after flying over Kanyakumari and refuel before proceeding to Cochin. On hindsight, this turned out to be a good decision as the route to Kanyakumari was covered with low clouds and occasional patches of rain. We were forced to remain below the cloud cover and had to deviate frequently from the route to keep clear of low stratus and rain. The on-board GPS sets proved useful during such situations. The moving thumb-along-the map, clock and compass method of navigation breaks down completely if you encounter bad weather and have to deviate frequently. A pilot's biggest worry is then to determine the course/distance/time to the next destination. Here, we had no such problem. Kanyakumari town is situated on the coast whilst there is a temple situated on a rock a kilometre out to sea, named after the famous Swami Vivekananda. It was raining over the town, and as we circled around the rainy patch, we located Vivekananda rock by coming around over the sea. We retraced our route back to Trivandrum and topped up the Pushpak for the flight to Cochin.

The track between Trivandrum and Cochin runs all along the West coast. The route was overcast with low stratus and occasional drizzle. We stayed below the cover once again, often flying at barely 200ft. Ten miles south, we met up with two Islanders of the Indian Naval Base at Cochin, who escorted us to the airbase. Cochin gave us a warm welcome where the top brass of the Naval Command turned up for the reception. Getting weather reports and flight clearance at various service bases barely took any time, in sharp contrast to the agonising delays at the civil bases. Notwithstanding the warm hospitality, we spent a frustrating afternoon in Cochin. Our next night halt was Bangalore. However, each time we made an attempt to walk-up to the aircraft for our flight to Coimbatore and Bangalore, the base was inundated by a fresh spell of rain. Finally, we had

Pushpak VT-DWA over the verdant fields of South India

to call it a day and push the Pushpak with its soaking wet fabric into a hangar for a night-halt at Cochin. Thus, it appeared that we had already lost a day which we had allowed for such contingencies. A message was passed to the ops room at Bangalore to this effect. They were, in turn, requested to inform Hyderabad, our next halt, about the change in programme. Next day's workload appeared light. Coimbatore ATC (Civil) starts work only after 0900. It would be a Sunday and a closed day at the Naval Base. Therefore, we decided to take-off at a comfortable time of 0900.

That night, however, it turned out that there was a great deal to be figured out owing to the change in plans. A reception had been planned in Hyderabad on 9 November by the AeSI. The fuel for the Coimbatore-Bangalore flight was stored in the hangar of a local flying club at Coimbatore, thus I called the OC of an Air Force establishment at Coimbatore to request transfer of this fuel to the nearby Air Force base of Sulur. Thereafter, I called up the AOC-in-C of Southern Command at Trivandrum and requested him to permit us to land at Sulur and activate the base accordingly. Finally, we requested the local authorities to launch us early, weather permitting. The weather gods were kind the next morning, and after a brief fuelling halt at Sulur, we reached Bangalore. (*Vayu was present !*)

From here, Ramanathan replaced Raveendran as my co-pilot. After a quick lunch, we were off to Hyderabad via Bellary. We made it to Hyderabad almost on schedule. In the sheer excitement of catching up with lost time, we forgot about flight fatigue. It was worth the effort, as the local branch of AeSI had arranged an impressive reception. Apart from local dignitaries, a large number of schoolchildren were present. The children were dressed in 'Freedom Flight' t-shirts donated by IOC and waved national flags with 'Freedom Flight' inscribed on them. The function was covered by both the print and electronic media. In fact, by now, the *Freedom Flight* was figuring regularly in local newspapers and the evening regional TV newscasts.

On the fourth day of our venture, 10 November, we flew from Hyderabad to Bhopal after two refuelling halts at Nanded and Akola. Nanded and Akola are disused airfields and our ground party provided us fuel here (also at Bellary the previous day and at Kota the next day). We had to delay our take-off from Nanded in order to accord adequate time for the ground vehicle to reach Akola before our arrival there. This halt enabled Ramanathan and me to visit the historic Sikh gurdwara there.

Our landing at Bhopal provided the only worrying moments of the flight. ATC Bhopal gave us clearance to join circuit and reported 6km visibility. To us it looked far less and quite hazy as we approached long finals. A thunderstorm hit the airfield when we about a kilometre away with heavy rain and strong cross wind. However, we had no choice since a go-around would have got us into IMC. I kept the power on with more than half aileron into wind and waited for the wheels to touch ground and only then eased back on the throttle. Back on the parking tarmac, we had to wait in the cockpit till the rain abated and then came out to a warm (and wet) welcome by the local authorities.

We reached Safdarjung airport at New Delhi on 11 November, slightly ahead of schedule, after two refuelling halts at Kota and Jaipur. The aircraft was given a thorough check-up at Safdarjung on 12 November and both the air and ground crew got a much-needed rest. The send-off ceremony at Delhi on 13 November was a small but solemn affair, with Dr Abdul Kalam, then scientific advisor to the defence minister, as chief guest. (*Vayu* was present) The flight to Chandigarh was uneventful, and on 14 November, a grand send-off function was arranged by the local Air Force base commander where a large number of schoolchildren were invited.

Civil flights from Chandigarh to Jammu have to follow a circuitous route to avoid flying close to the international border with Pakistan. We requested and obtained

direct routing, overflying Pathankot, under Air Force radar control. Army authorities provided a Chetak helicopter to airlift our mechanic and overnight clothing to Jammu located at the foothills of Kashmir's mountains. The route from Jammu to Srinagar is strewn with hills on either side, the peaks going up to 16,000 ft. The minimum obstruction clearance altitude (MOCA) is 16–17,000 ft. However, a valley zigzags its way up to Banihal pass, located at 9,500 ft, which is the lowest point to cross over to Srinagar. I decided to follow the route Jammu-Udhampur-Kud-Ramban-Banihal-Srinagar. I had kept an option open to fly alone from Jammu to Srinagar in case of marginal weather conditions. This would have kept the AUW low and enabled slightly better rate of climb. However, the weather conditions were near perfect and temperatures ISA -5°C. So, Ramanathan and I set off on the all-important final leg of our journey. Army authorities once again provided a helicopter, this time a Cheetah, to airlift our mechanic and overnight clothing to Srinagar.

There is a very gradual rise in the terrain between Jammu-Udhampur and Kud. Despite the aircraft's low rate of climb, we were able to gain sufficient height to clear the hills without deviating from the track. The aircraft performed well and we cleared Banihal pass by a comfortable 1,000ft flying at 10,500 ft. Because of unlimited visibility, we could see all the surrounding snow-covered peaks and the view was breathtaking! We landed at Srinagar in near freezing conditions but the Air Force base accorded us a warm welcome. We spent a comfortable night in the officer's mess and set off on our return leg the next morning.

Return Leg

Our return journey from Srinagar to Bangalore went like clockwork. In fact, we were ahead of schedule most of the time. Bad weather, however, still dogged us almost throughout south of Delhi, right up to Jaipur and Kota; it was poor visibility owed to dust and smoke. Further south from Kota towards Bhopal and in fact, right up to Bangalore skies were covered at levels we were interested in flying, between 6 and 10,000 ft. Whenever we could not avoid clouds by deviations, we had to descend below clouds where flying conditions were very turbulent. Part of the final leg to Bangalore was flown at 1,000 ft. frequently avoiding rain patches. GPS proved an exceptional navigation aid under these circumstances. We touched down at Bangalore airfield on the afternoon of 19 November, an hour ahead of schedule, with a great sense of relief and thanksgiving!

A Rewarding Experience

The Pushpak aircraft performed exceptionally well. There was not a single snag throughout our journey, although our ground vehicles were loaded with spares, we did not need a single consumable. Oil leaks from the engine were minimal, less than 100 ml per hour. I was very happy with the selection of my co-pilots. Raveendran was a sobering effect whenever I tended to venture into marginal weather in the southern sector. Ramanathan was a big help sharing the flying task and continuously punching GPS buttons. Our ground party had a strenuous task, often travelling throughout nights to keep up with us. The communication facility provided by DEAL, Dehradun was a boon. People everywhere were full of praise for the round-the-clock functioning of the operations room at HAL.

In retrospect, it is difficult to imagine undertaking and successful completion of a venture of this nature without the tremendous administrative effort and organisation by Aeronautical Society of India and HAL. For Ramanathan and me personally, *Freedom Flight* has been a rich and rewarding experience and we are grateful for the privilege accorded to us.

Air Vice Marshal AS Lamba (retd)

The intrepid crew : AVM Ajit S. lamba (right) and S. Ramanathan

'Noble Arrow 2014'

A Hellenic Air Force Mirage 2000-5 from 331 Mira taxies to the runway

French NRF-2015 qualifications

The NATO Response Force (NRF) is a highly prepared and technologically advanced multinational force that is made up of land, air, maritime and Special Operations Forces (SOF) components which the Alliance can deploy quickly to any location where they are needed. In addition to its operational role, the NRF provides a means to demonstrate operational readiness and acts as a 'test bed' for Alliance transformation. It can be used in the implementation of NATO's Connected Forces Initiative (CFI) as a vehicle for greater cooperation in education and training, increased utility of exercises and better use of technology.

During the NATO Summit in Wales, held in September 2014, member nations agreed to create a spearhead within the NRF — a Very High Readiness Joint Task Force (VJTF) — able to deploy at very short notice, particularly at the periphery of NATO's territory. The VJTF is to consist of a land component with appropriate air, maritime and SOF assets available. Allies also agreed to hold a high-visibility exercise, '*Trident Juncture* 2015,' with 25,000 personnel, including the NRF, to be hosted by Italy, Portugal and Spain. In addition, a broader and more demanding exercise programme will be instituted from 2016 onwards, with the NRF as a key element in the exercises.

The NRF currently comprises three parts: a command and control element from the NATO Command Structure; the Immediate Response Force (IRF), a joint force of around 13,000 high-readiness troops; and a Response Forces Pool (RFP), which can supplement the IRF when necessary.

The NRF was established in 2002-03 and has been deployed six times including the 2004 Olympic Games in Athens, Iraqi elections, Libyan civil war, Aghanistan (humanitarian relief), *Hurricane Katrina* in 2005 (humanitarian relief) and the Pakistan earthquake in 2006 (humanitarian relief).

With current political and military changes in Europe, the current focus of NRF in 2015 will be on a large-scale intervention in the periphery of the NATO countries.

Noble Arrow 2014

Noble Arrow 2014 was held in France from 13 to 29 October 2014 and involved the participation of 14 nations. This complex air-exercise included approximately 40 French and 20 Allied air assets and was coordinated from the Joint Force Air

Turkish F-16s at Nancy-Ochey air base (photo: Joël-Weyer)

Greek Mirage 2000–5s throttle up on the runway prior to launch

Component Commander (JFACC) at the Mont-Verdun airbase near Lyon (France). *Noble Arrow* 2014 was part of the qualifications that the French Air Force had to pass in order to be able to lead the aerial component of the NATO Response Force (NRF) in 2015. A media visit to Luxeuil airbase (*Base Aérienne* 116, named 'Lieutenant-colonel Tony Papin' and located near the commune of Luxeuil-les-Bains) was organised during the last week of this large-scale exercise.

Approximately 1000 personnel from the participating NATO members (Belgium, Canada, Denmark, Estonia, Germany, Greece, Italy, Spain, Turkey, United Kingdom, United States) and non-NATO nations (Sweden, Switzerland) were involved in the exercise. The exercise was linked with the French Air Force (*Armée de l'Air*, AdlA) exercise *Volfa*, the French Army exercise *Toll* and the French Navy exercise *Catamaran,* which gave a unique opportunity to train cross-component interaction. Around 130 of the personnel were assigned to the command-centre at Mont-Verdun in Lyon. Although the exercise started on 13 October, the first missions were flown on the 17th. The main operating areas during the 9 flying days were located in the centre and the south-east of France. Every day an average of 100 daytime sorties were flown, with additional night sorties on 22, 23 and 28 October.

The French Air Force took part with Dassault Rafales from Saint-Dizier and Mont-de-Marsan, Mirage 2000s from Nancy and Luxeuil, and Alpha jets from Cazaux. The French transport fleet was also involved and saw the participation of Lockheed C-130s, Transall C160s, and Casa CN235s. Besides the fixed wing elements there also were EC725 Caracals, SA330 Pumas, and AS555 Fennecs participating at various locations. In order to provide the JFACC in Lyon with the necessary information a French E-3F flew missions from its home base, Avord, and because all these various air assets needed to be refuelled, a number of French C-135Fs from Istres airbase were on call in assigned refueling tracks, along with American KC-135s and a German A310MRTT flying from their home bases, RAF Mildenhall in the UK and Koln-Bonn airbase in Germany respectively.

One of the Greek Mirage 2000-5s rolling for takeoff from Luxeuil

The French Navy operated their aircraft from the Naval Bases at Lann-Bihoué and Landivisiau, augmented by the French aircraft carrier *Charles de Gaulle*. The French Navy participated with the Atlantic II, Rafale M, and Super Etendard. Besides the US and German tankers there were numerous other foreign participants. German C-160 Transalls, USAFE F-16s, and Swiss F/A-18 Hornets flew missions from their respective home bases. The Hellenic Air Force deployed 4 Mirage 2000-5EGs from 331 Mira (Squadron) to Luxeuil and the Turkish Air Force sent 5 F-16s to Nancy-Ochey. Besides NATO forces, this *Noble Arrow* exercise was open for countries of the Partnership-for-Peace programme, which allowed Swiss F/A-18s to participate from their home base in Switzerland.

Exercise *Noble Arrow* 2014 was the aerial component of a broader set of NRF preparation exercises, aimed at aerial, naval, and ground forces. Every part is under the command of a NATO member country and the French Air Force will command the aerial component in 2015. The other elements of the NRF have separate qualifying exercises. For instance, the Spanish Navy will command the naval component of NRF 2015. In order to qualify for this command Exercise '*Noble Justification* 2014' was held between 13-26 October. As many as 23 surface warships, six submarines, 30 aircraft and 5,000 personnel from 16 nations took part in the exercise, which was conducted off the Spanish coast in the Mediterranean Sea and Atlantic Ocean. For the land component, the *Noble Ledger* 2014 exercise spearheaded by the German-Dutch battalion was held in Norway in September, with focus on a large anti-invasion operation. There was also an SOF exercise, on which little information has been released, except to confirm that the Polish Army will command the NRF 2015 Special Forces component.

Text and photos:
Joris van Boven and Jan Kraak

USAF/HAF: Strengthening of Ties

Under leadership of the United States Air Force Europe (USAFE), the Germany-based 480th Fighter Squadron 'Warhawks' exercised with the Hellenic Air Force during the second and third weeks of August 2014. Eighteen Lockheed Martin F-16 Block 50 Fighting Falcons relocated to Souda Bay Air Base on the island of Crete to join the local 115 *Pteriga Mahis* (Combat Wing) for a bilateral training for two weeks, partnering with the local based 340th and 343rd Fighter Squadrons flying Lockheed Martin F-16 Block 52 Fighting Falcons.

Atlantic Resolve

In light of the on-going Russian 'intervention' in the Ukraine and build up of Russian military forces, the United States has intensified their commitment to the collective security of NATO allies and showed their support to the partners in Europe. All actions are taken under the umbrella of operation *Atlantic Resolve*. By augmenting the air, ground and naval presence in the region and enhancing previously scheduled exercises, the United States took several immediate steps to demonstrate its solidarity with NATO allies. Included in these actions are the continued presence of an Aviation Detachment (AVDET) at Łask Air Base (Poland) and the air refuelling missions in support of NATO airborne warning and control system (AWACS) aircraft over Eastern Europe. The bilateral training held in Greece is in line with the presence that the United Stated wants to demonstrate to its NATO allies as well to Russia.

Large Force Exercise

The main purpose of this training exercise or Flying Training Deployment (FTD) as it is referred to by the USAF, is to gauge the compatibility between the two nations with focus on strengthening joint readiness. Lt.Col David Berkland, the squadron commander of the *Warhawks* and detachment commander (DETCO) for this exercise, explains; "The purpose of this FTD is to train participating units in combined air operations and extend our joint war fighting capability through operational training. The scenarios that we are enacting with our host nation partners involve large force exercises that represent realistic combat situations. These large force exercises include counter-air and counter-land missions, and involve our Hellenic counterpart's airborne and ground forces. The US and Greece, as NATO allies, share a commitment to promote peace and stability, and training in these realistic scenarios prepares us to uphold this commitment should we be called upon to work together in future real-world situations."

Similar–but different

One might wonder why the USAF is choosing to team up with a weapon system similar to one, in this case the F-16, which the unit is already flying. It could be more interesting to look for a unit that is operating a different airframe, like the Eurofighter, to be able to explore the opportunities and capabilities of such a platform. A different perspective on this matter was pointed out by Lt.Col Berkland, "We're more concerned with capabilities than airframes, and the Greek F-16 is a multi-role aircraft suitable to many different scenarios that fit our training requirements in support of potential combat operations. Whenever we train with our NATO partners, we are concerned foremost with honing our shared capabilities rather than just working with a particular airframe. Approaching the training from this perspective builds upon our nations' collective capabilities, ensuring a much stronger partnership and enhanced interoperability."

Importance

The 480th FS normally flies training missions close to its home station in Germany. That might become routine at a certain point: wake up in one's own bed, work in a familiar environment, and conduct

business as usual. Chances however are that in a contingency operation, the 480th FS will not be flying in the airspace of its home station. In the USAF, units strive to practice like they fight, and that requires the 480th FS flying in different environments so that it will be prepared for whatever situations the squadron might face in the future. Lt.Col Berkland added, “Our forward presence in Europe allows us to work with many of our allies and partners, including Greece, to develop and improve ready air forces capable of maintaining regional security. Another important aspect of training away from home station is that when we deploy, it's not just aircraft and pilots - we take the whole squadron: operations, maintenance, logistics, and security forces. The entire team needs to be familiar with how to operate in an unfamiliar location, and the more unique experiences we can get in a training environment, the more prepared we will be if called upon for a combat operation.”

The exercise was launched by the commander of the 115 Combat Wing, Colonel Ioannis Gerolimos. "As a fighter pilot myself, I am keenly aware of the importance of these kinds of exercises," the Colonel said. "My aim is to make sure that the 115th CW is ready to deal with any operational situation in any environment. Also, this training exercise - with the participation of the 480th - gives us both the essential means in maintaining and enhancing the ability of our involving personnel to work together, which will be increasingly important to meet future challenges as allied air forces."

The importance of this exercise to the HAF was emphasised by the presence of Chief of the Tactical Air Command, Lieutenant General Christos Vaitsis at Souda Bay Air Base on 20th August. He was informed by the Colonel Gerolimos on the progress of the exercise and flew a mission in the back of a F-16D during the morning to experience the exercise at first hand.

An important asset of the exercise was the practice of air-to-air refuelling. A KC-135R of the 351st Air Refuelling Squadron(ARS) based at RAF Mildenhall, England flew local air refuelling missions from Souda Bay Air Base during the first week of the exchange. At the end of the first week the KC-135R returned home and flew its missions during the second week out of RAF Mildenhall to continue to support the exercise. As the Hellenic Air Force does not have its own air refuelling capability this opportunity was utilised fully to get as many aircrews (re-)certified as possible. Therefore F-16s from all Combat Wings of the Hellenic Air Force approached the tanker during the two week exercise, some for multiple dry hook ups which means no actual kerosene was transferred by the KC-135R to the F-16s. Captain Travis Epp, KC-135R pilot of the 351st ARS explained: “The Greek pilots only made dry hook ups and did so daily during the exercise. It was their choice to only do the procedural air refueling training and not take the actual gas when hooked up to us. Considering that they don’t have their own air refuelling capability the Greek pilots did very well.”

Success

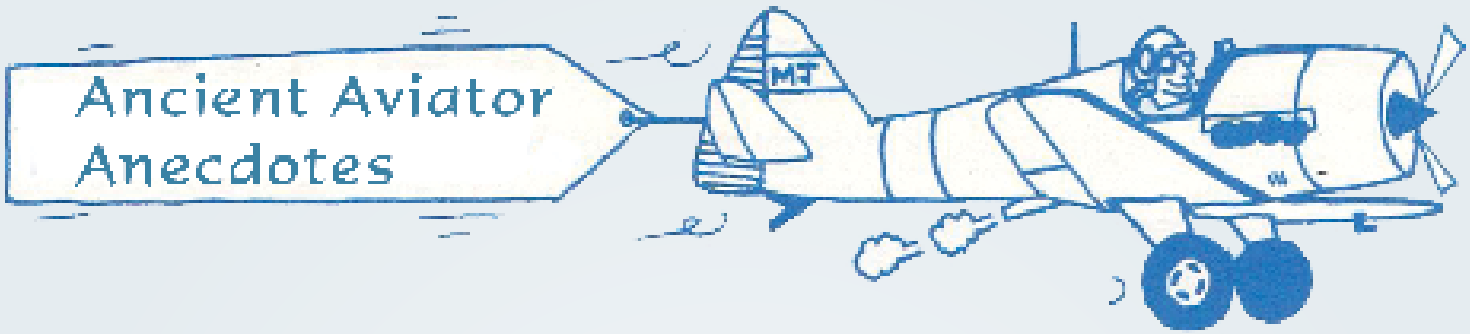
The 480th FS deployed to Souda Bay with 16 F-16CMs and 2 F-16DMs (used for cross training with Greek pilots) and around 300 supporting personnel including thirty-five fighter pilots. Berkland: “While the aircraft obviously do not fly without the pilots, the fact that they make up only about 10 percent of the personnel we brought with us is testament to the fact that we can't fly without the support of the rest of squadron as well. From the operators in the cockpit, to the maintainers that ready and recover the jets, and everyone else in between, it takes the whole squadron working together to accomplish our mission. Every day, we're working on interoperability," he emphasised. "It's absolutely essential to our ability to go to war with our coalition partners, and we train like this so that on day one of a conflict, we've already worked out a lot of these interoperability issues."

The same opinion was shared by his Hellenic counterpart: “I think everything went well," said Lt.Col Michail Tsikalakis, 343rd FS commander of one of the two F-16 units based at Souda Bay Air Base. "Greece and the United States are proven partners with a long military relationship. It's strong, I think, and based on common values of democracy and freedom. We've had many (cooperation events) throughout the years, and we're looking to future challenges, training how we fight. We are confident to fly with the American pilots now," he continued. "We have common training and common procedures. We see in the air that it works, and we're ready to fly and fight in a war together."

Lt.Col Berkland concluded: "Anytime we complete a training deployment having flown, fought and learned as a squadron, the training is a success. The experiences we garnered over the last two weeks with our Hellenic Air Force counterparts will make us better operators and maintainers, and overall better Airmen and coalition partners. Successful flying training deployments like this ensure that we are equipped for the challenges of the future as one force with our NATO allies."

Thanks to Lt. Col Berkland, Miss Gault, crew of Quid78 and the Mildenhall PA staff for supporting this article.

Remco Stalenhoef



Air Vice Marshal Cecil Parker recalls

Alpha to Omega to Alpha

In our retired community of armed forces veterans, birthdays are often the catalyst for get-togethers and social intercourse. In early August my wife and I received invitations to three different birthday parties, all of them to be held within the span of one week. This unusual concentration of dates was to mark the 100th birthday of a widower, followed by the 94th and 90th birthdays of two widows. While the first two parties were being held in Secunderabad, the third was to be held in Mumbai.

None of the celebrants were actually related to us, but all three were parents of good friends. In the mosaic of faith that makes up our country, one happened to be a Hindu, one a Christian and one a Muslim. Two of the three had children who were themselves defence services officers or married to one, while the third was a civilian. One chose the celebratory meal as dinner, one as tea and the third as lunch. The first two were held at home for a few friends and family while the third was held at a starred hotel for 100 guests.

At these functions we were of course delighted to catch up with so many friends made during our years on air force airfields or military establishments all over India and abroad. But it was uplifting to observe the mental alertness of the three 'Stars' each one of whom were blessed with loving and supportive children, grandchildren and great grandchildren – a tribute to their own role as parents. Quite frankly, in their dignified and wise presence, I in my 82nd year, felt like a novice fresher.

On our return from Mumbai, waiting in our mail box, was an obituary notice. A friend and neighbour in his mid-70s had unexpectedly passed away that very morning. 'Three Birthdays and a Funeral' could well have been the title of this piece but as the French say, *ce'st la vie* (such is life), and life of course must go on – to the next birthday.

Avian Risk Management

As a term, risk management is associated with investment banking and is concerned with the safety of financial capital. As an activity in aviation however, it has been in practice ever since man took to the air and seeks to preserve human capital. Innovation and technology led to the invention of the parachute and, thanks to one, I saved my own life in 1952. In furtherance of risk management, procedures, rules and regulations evolved, some critical ones being codified into 'Vital Actions'. The term is familiar to aviators all over the world and comprises mandatory checks at different phases and conditions of flight. Most aviation activity takes place at altitudes at which birds do not fly but in any operation close to the ground (take-off, landing, and

low-level exercises) manned flight enters the avian domain where aircraft and bird pose a danger to each other. This risk has to be managed by the aviator and not left to the birds – after all, they were there first!

In 1970, while in command of a Hunter squadron, I was tasked with carrying out live firing field trials of the 68 mm Sneb Rocket Pod. I was further advised to carry out this initial trial from the twin seat trainer so that another pair of eyes could help with visual observation / lookout while I concentrated on the firing. One of my very experienced pilots had just returned from long leave and, as per regulations, was required to be given a dual check. Trainer flying hours were always at a premium so I decided to combine both commitments. The trial firing was to be conducted at the nearby Tilpat Range and involved a single live firing in 'salvo' of both pods which I estimated would take me no more than 15 minutes leaving us with 30 minutes for the dual check. I put the co-pilot into the left (captain's) seat while I flew from the right (instructor's) seat and briefed him for both exercises.

The weather was fine and, after a practice dummy dive, I fired the pods and was pulling out of the dive when three occurrences took place almost simultaneously: a fleeting glimpse of a very large bird; a loud sound of the front windshield cracking and a muffled squawk on the radio saying 'Birds Birds'! I saw my co-pilot with his helmet visor up, i.e. open, and both hands covering his eyes. Due to the sudden inrush of air there was neither inter-communication possible between us, nor any radio contact with the ground. In response to my visual signals the co-pilot gave me a 'thumbs up' but continued to keep his eyes covered. I returned to base, carried out a very quick emergency unserviceable R / T procedure, landed after the green visual signal but only at the end of the landing run could I open the canopy and request for medical help which was waiting by the time I switched off at the tarmac. Fortunately the co-pilot's facial injuries were superficial, a spare windscreen was available and both pilot and aircraft flew a few days later.

In retrospect I was also culpable to the extent that, as captain of the aircraft, I should have noticed the co-pilot raising, i.e. opening his helmet visor evidently to observe more clearly. Every time an aviator transits or operates within the avian domain, constant lookout is the essence of risk management. Some measure of risk will always exist but if the pilot is careful (and lucky), he will be a winner; and if not, he will certainly be wiser!

(Postscript: in partial compensation for the bird hit, my Log Book records that the rockets were a direct hit!)

Sunrise at Sunset

If told that it is possible to see the sun set, rise and set again, all in the space of a few minutes, the reader would be understandably sceptical. To observe this unusual phenomenon however, one needs to be at the right place, at exactly the right time and in the right aircraft. Our Air Force provides the opportunity to meet all three requirements to its aviators in the course of their normal duties. During 1966-69 I was in command of a Hunter equipped unit at Jamnagar tasked with the conversion and operational training of newly commissioned young pilots of the fighter stream. Though under HQ WAC in New Delhi, the unit had a war role for which we came under HQ Western India (WI) at Poona.

Night flying was a regular feature of staff continuity training and was carried out in two phases: 'Moon Phase' (a week on either side of a full moon) when there was a distinct natural horizon and visual flying was possible, and 'Dark Night' when there was absolutely no horizon and pilots were on instruments almost entirely from take off to landing. Such training certainly sharpened our flying skills especially as the Hunter had neither on-board navigation aids nor a landing light.

The then AOC WI was a strict, no-nonsense Air Vice Marshal with a volatile personality, short fuse, colourful linguistic skills and an intimidating bearing. On one of his short notice visits he learned that we were carrying out 'Dark Night' flying training that night; he immediately expressed a desire to be taken up in the Hunter trainer aircraft. I instructed my Flight Commander to include him in the flying programme and to ensure that an experienced QFI (Qualified Flying Instructor) took him up. Shortly thereafter the Flight Commander came to my office and, with a deadpan face (we were good personal friends), conveyed the unanimous opinion of all our QFIs that the privilege of taking up the AOC WI on a dark night, should be that of the Commanding Officer-exclusively!

On 17 October 1967, while briefing AOC WI for the sortie, I asked him if he would like to see the sun set, rise and set again all within 20 minutes from take off. He appeared to be nonplussed but just nodded his head and was not his usual vocal self while being helped to strap up in the right hand seat of Hunter T.66 (BS364). As the sun began to set, we started up the engine, taxied out and parked briefly on the 27 dumbbell of our East-West runway to watch the sun set completely and darkness commence. We took off and climbed due west on a heading of 270 degrees. As we gained height, the tip of the sun appeared again and with an increase in altitude it kept rising till at 40,000 feet it was almost entirely visible. As we levelled out and maintained height and direction, it then began to sink again more rapidly. We were now 65 nm from base over the Arabian Sea and were able to observe the sun set completely once again. To our far right the glow of the lights of Karachi city was faintly visible. (Little did I know that two years later I would land the first IAF Hunter aircraft at sunrise at Karachi International airport while on a ferry flight from the UK to India).

Our return to base for the controlled descent and landing was in pitch black conditions requiring my full attention to instrumental flying and I was grateful for the silence of my co-pilot. After the flight I asked him if he had any questions. His response was: "Nosey, two sunsets and a sunrise on a dark night certainly make a[*expletive deleted*] sight!"

Air Vice Marshal Cecil Parker (retd.)

25 Years Back

From Vayu Aerospace Review Issue I/1990

Republic Day 1990

For the fifth year in succession, there was no flypast by the Indian Air force during the Republic Day parade at New Delhi. The increasing danger of bird hits over the densely thronged Raj Path is the official reason for the cancellation of the flypast. Instead, the IAF had two of its frontline combat aircraft types towed along the parade on trailers, these being the HAL-built Jaguar-DARIN and MiG-27ML, along with a representative range of their air-to-ground armament.

PTAs and RPVs

In his presentation at the Aeronautical Society of India, Director of the Aeronautical Development Establishment (ADE), Dr KG Narayanan, said that the Pilotless Target Aircraft (PTA) currently in the advanced stage of flight testing, would enter actual service with the Army, Navy and Air Force in 1992-93. Apart from the PTA, another unmanned air vehicle under development is the mini-RPV (Remotely Piloted Vehicle), capable of day and night reconnaissance and surveillance. There are possibilities for the export of the mini RPV as well.

Two satellites launched annually

According to Prof UR Rao, Chairman ISRO, India is on the threshold of acquiring capability to launch up to two satellites every year in the coming decade. For this he stated, launch vehicles will operate through adequate experimental and developmental flights and the decade 1990-2000 will witness a number of new developments plus the establishment of requisite facilities. Professor Rao said the space and engineering industries, which have already had major areas of interaction, would now be more closely aligned for the pursuit of the country's space programmes.

Army's Helicopter Base

Lt General Jagat Mohan Singh GOC XXXIII Corps inaugurated the Army's first helicopter base in the eastern sector on 1 January, 1990. The base, which includes a helipad, hangers for helicopters and maintenance workshops, will now be manned by Indian Army personnel, the helicopter operations hitherto having been supported by Indian Air Force maintenance personnel.

New HAL Corporate Building

The President of India formally opened HAL's new corporate office at Cubbon Road in Bangalore on 15 December, and at which time he commended HAL's present efforts in design and development activities, particularly on the Advanced Light Helicopter (ALH) programme. He was glad to note HAL's involvement and cooperation with other R&D organisations in the Light Combat Aircraft (LCA) programme and as these were projects of great national importance, "they should be pursued most diligently with an eye on excellence in performance and quality." The President, however, noted that HAL's involvement in the field of civil aircraft was rather limited but in the coming years, with the great expansion in civil aviation, larger opportunities were inevitable.

Additional Sea Harriers

The next batch of Sea Harriers on order for the Indian Navy, have been ferried from the UK by BAe pilots to the Indian Naval Air Station *Hansa* at Goa. These Sea Harriers will augment in the earlier batch with INAS 300 *White Tigers*, and the remaining aircraft (batch of 19) would be utilised to form a second unit.

The Indian Naval Sea Harrier FRS Mk. 51 has enhanced fighter, reconnaissance and strike capability. In the fighter role they will be armed with R 550 Super Magic air-to-air missiles and in the anti-shipping role, they will carry the Sea Eagle sea-skimming missile. Both the Indian aircraft carriers, INS *Vikrant* and INS *Viraat,* meanwhile, have been fitted with ski-ramps for enhancing Sea Harrier operational capabilities.

India Can Develop 'Hyperplane'

Mr APJ Abdul Kalam, Director Defence Research and Development Laboratory (DRDL) at Hyderabad has said that Indian scientists are working on conceptual studies to develop a futuristic 'Hyperplane' using the consortium approach successfully applied for indigenous fabrication of the 'Agni' missile. The 'Hyperplane', or the hypersonic platform, could take-off from any airport for an air-breathing ascent to near earth orbit, then enter space for a satellite launch or contact with a space station, and finally return to earth for a horizontal landing.

HAL's 50th Year

On 23 December, 1989, HAL entered its fiftieth year of existence with appropriately, its new corporate office on the prestigious Cubbon Road having been formally inaugurated by the President of India a week earlier. Wg Cdr IM Chopra, Chairman HAL stated on the occasion that HAL had made a major breakthrough in exports following the MOU with Aerospatiale for the supply of 600 sets of forward doors for the Airbus A 320 aircraft.

French Arms for India, Pakistan

Prime Minister of France Michel Rocard has said that while France was restructuring its defence industries to lessen its dependence on exports, it would not stand by and allow other countries, especially the US and the UK to promote arms exports at the cost of the French Industry.

These observations regarding possible French sales of military equipment to India (155mm SOFMA howitzers) and Pakistan (Mirage 2000 fighters) during his press conference in New Delhi on 19 January. He declared that his country's policy was not to encourage an arms race anywhere in the world but at the same time it could not ignore the fact that various countries had legitimate security requirements.

Miles to Go...

Vayu heads to its Half Century !

A milestone is a marker along the side of a road to reassure travellers that the proper path is being followed, and to indicate both the distance travelled and the remaining distance to a destination. *Vayu Aerospace and Defence Review* celebrated a milestone of its own in November 2014, completing forty years of publication. Apart from a great party held at the India Habitat Centre in New Delhi, *Vayu* celebrated this occasion with an anniversary issue that, among other things, reflected on forty years of recording and analysing events critical to aerospace in India as also the neighbourhood, plus programmes of future pertinence. Most importantly, though, this 'look-back' starkly emphasised that even while we have traversed a long path, we have miles to go…

Over the decades, *Vayu's* readership has grown and expanded to various parts of the world. There are myriad of enthusiastic readers, both in India and abroad. It is more than satisfying, for instance, to be informed by many senior officers in India's armed forces today, that they were "inspired" to enter the profession after becoming avid readers of *Vayu* in their school and college years. A present two-star ranking officer confessed that he has kept every issue of *Vayu* ever published, which is gratifying indeed!

As too, internationally. A dedicated reader of *Vayu* in Germany writes, "What you have achieved in the years passed is most remarkable. I do not know a single magazine in the world which has condensed information that *Vayu* provides. With the emphasis on Indian aerospace and defence, it covers also worldwide activities and developments. It is no wonder that reading *Vayu* is a must for every professional."

"*Vayu* has reached such a reputation that it is an honour for high ranking officials to publish their opinion on most interesting subjects," feels an aerospace industry leader in Europe.

Others have echoed the sentiment; "It is really an achievement, given the fact that there are hardly any aviation journals in India that have covered so much on international and regional aviation over the last forty years."

A reader in Gurgaon has complimented the journal saying, "I am happy that your magazine has completed forty years. I congratulate you on this achievement and the position your magazine has reached. *Vayu* is a highly respected magazine in aviation and defence circles. This could be achieved only by your hard work and talent."

A senior executive of a European multinational group has extended his 'warmest congratulations', adding that "*Vayu* is indeed a credit to India. Your team has an immense in-depth technical knowledge and is a highly respected news resource. Our company has enjoyed a long and faithful relationship with the journal and we are pleased to have been a part, just as a minor contributor, of your success story."

"Hearty congratulations for taking the magazine very successfully through forty long years, winning a large number of admirers, getting nominated for several prestigious international awards, focusing on matters of aerospace and defence of global and national importance, providing a much needed historic perspective, which India is not famous for, lavishly illustrating it with appropriate visuals, though not easy to get hold of unless you travel several extra miles and finally not succumbing to negative writing to sensationalise issues," gushed a Bangalore-based aerospace consultant.

The *Vayu Aerospace and Defence Review* is in for the long haul, even as India's aerospace industry girds itself for a new era and this journal promises to keep pace over the times ahead. Read on !

Tale Spin

'Make in India' like the ancients !

During the recent 102nd Indian Science Congress, Captain Anand Bodas, a retired pilot, claimed that if India made alloys as per Maharishi Bharadwaj's *Vimana Samhita*, then the need to import today would be eliminated. The wise captain also announced that ancient Indians had developed a radar system named the *rooparkanrahasya* (make way Elta EL/M 2032)! As for airliners, ancient India had jumbo aircraft around 60 x 60 x 200 feet, powered by 40 small engines (talk of power-to-weight ratios). Ancient India's aircraft could not only move in any direction, but travel between planets, it seems.

Are you listening ISRO, ARDC, ADA and NAL ?

Artificial Intelligence for Human survival

The distinguished physicist Stephen Hawking has warned that development of full-fledged, autonomous Artificial

Intelligence (AI) could well spell end of the human race. He warns that there already are supercomputers which can outsmart the smartest of human beings and AI could well spawn even smarter clones. This doomsday scenario is countered by other views that human-like machine intelligence can leapfrog the Darwinian time scale, which may be the only guarantee of Earth's survival in the next 2000 years, as AI is driven by service, not conquest, empathy not enmity.

'Stand out' for luck !

The Mars Orbiter Mission has been touted as one of India's biggest achievements in space. But luck was invoked as later learnt. During the six orbit-raising manoeuvres and three trajectory corrections of the spacecraft, mission director S Arunan would slip out of the control room and stand (pray?) in silence.

"Call it superstition, but I believe that it brought us luck," said Arunan. In fact, even while security was space tight at PM Modi's visit to ISRO HQ to watch the spacecraft's launch, Arunan would frequently step out to get some "fresh air." Indians are no strangers to superstitions, but it is interesting to behold this phenomenon in scientists who debunk such notions for a living!

Pistol Packin' Mama

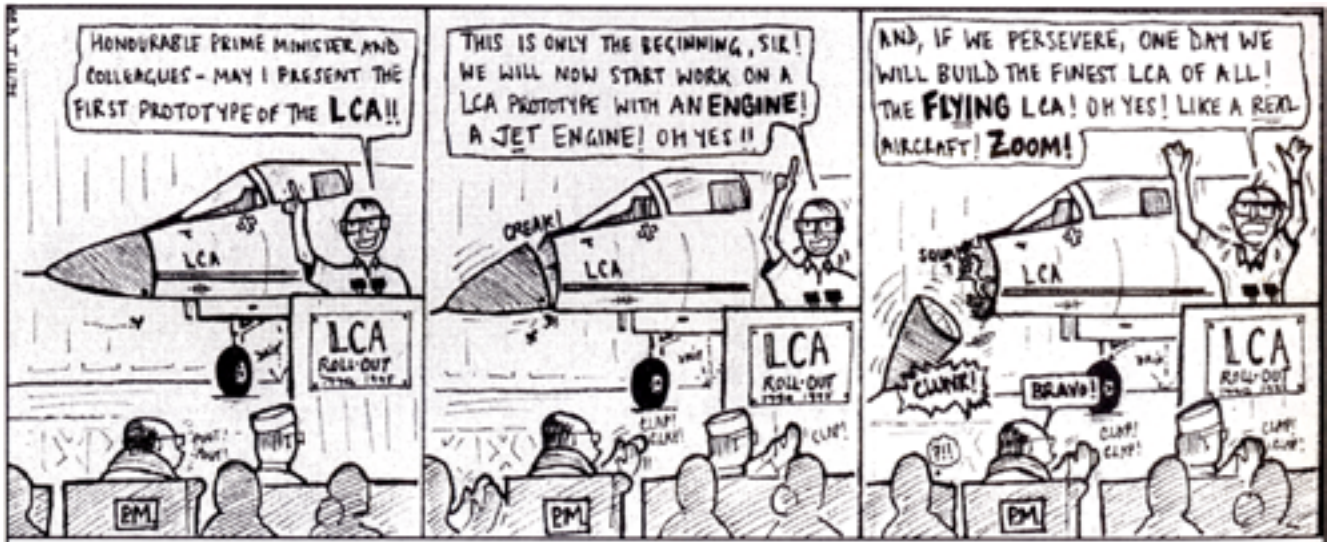
"Lay that thing down before it goes off and hurts somebody", joked Bing Crosby as he ad libbed in an interview following his performance of the 1943 song 'Pistol Packin' Mama' that became number one on the Juke Box charts.

Even as Britain has decided that the prevailing ban on women in combat roles will be lifted soon, India showcased its *nari*

shakti at Republic Day 2015, with women not only leading marching columns down Rajpath but all-women contingents given pride of place. The smart IAF woman officer who conducted the US President inspecting Guard of Honour at Rashtrapati Bhawan was cynosure of all eyes (500 million or more ?) and then at the parade itself, where they got Barack Obama's thumbs up !

Afterburner

Look back 20 years – and counting



(comic by Mohit Jayal in December 1995).

IAI Corporate

Shinmaywa