VAYU

Aerospace & Defence Review

II/2015

At and Beyond Aero India 2015

Aerospace : Vision 2050

Defence Budget 2015

Assessing the LCA's role

The 13th LIMA

Charles Lindbergh and India

Finmeccanica

IAF Hawks of the 'Surya Kiran' team over the Taj Mahal. The IAF has just re-formed its formation aerobatic team with the BAE Systems Hawk Mk. 132. This painting of the team with its new mount has been envisioned by Priyanka Joshi.

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40 "The iPhone of military training aircraft"

Grob's G120TP is fast becoming the basic trainer of choice across a multitude of Air Forces worldwide, and with good reason. *Vayu*'s Angad Singh recently caught up with Grob CEO André Hiebeler for a freewheeling chat about the company's star product and its recent string of successes around the globe.

43 At–and Beyond Aero India 2015

Aero India 2015 was inaugurated by Prime Minister Narendra Modi on 18 February 2015, where he exhorted the industry to 'Make in India'. The inauguration and subsequent events are covered in detail by the large *Vayu* team at Yelahanka, reporting and analysing various press conferences addressed by Defence Minister Manohar Parrikar, ("Defence Offsets … a Catalyst") CAS Air Chief Marshal Arup Raha, ('Chief Speak'), Chairman HAL T Suvarna Raju ("Champion of the Champion'), and DG (Aerospace) Dr K Tamilmani who focused on the AMCA. *Vayu* also features 'Mister LCA', meeting Gp Capt Suneet Krishna, arguably the most experienced pilot on type. Even as the first women officers joined the *Sarang* display team, the crowds at Aero India oogled at the 'Skywalkers' and 'Pussycats'.

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Preceding the Air Show itself, as has become routine, an International Seminar organised by the DRDO was held in downtown Bangalore with Minister of State for Defence Rao Inderjit

Singh, chairing the panel discussion on 'Window of Opportunities'.

82 The 'Best Ever' LIMA

An overview of the 13th Langkawi International Maritime and Aerospace Exhibition (LIMA'15) which took place virtually simultaneously with Aero India 2015, somewhat detracting exhibitors who had to choose from between these two Asian events.
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105 A Magnificent Man and his Flying Machine

Anand Sethi writes about the legendry Charles Lindbergh who flew a Miles M-12 Mohawk, custom–built for him, to India in February 1937. This virtually unknown story has been painstakingly retrieved by the author who researched the Lindbergh archives and gathered details (and photographs) of the historic flight in this exclusive article for the *Vayu*.

Also: Solar Impulse 2; PLA Navy warships; Remembering Maj. Gen. Atma Singh; Alenia Aermacchi at LIMA 2015

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Make in India

For any nation that aspires to be influential in global politics and aims to be a power to reckon with, military power is considered a paramount element. Thus Prime Minister Narendra Modi's 'Make-in-India' appeal makes sense in this context, considering that all powerful nations in the world are fairly self-reliant in defence technology and have a strong military-industrial complex. Yet the disconcerting fact is that despite being among the world's largest economies and having the fourth-largest military, India's all three armed forces remain heavily, rather helplessly, import dependent.

India imports almost 70 per cent of its defence hardware from several different countries. Even the 30 per cent indigenously developed weapon systems comprise mostly licensed production or transfer of technology from foreign firms. Then again, key components in projects undertaken by the defence research and development organisation (DRDO), the apex body entrusted with spearheading self-reliance in key defence technologies, and by some defence public sector units, are sourced from overseas and take far too long to develop. For example, India's indigenously developed Tejas light combat aircraft, which is yet to be inducted into the Indian Air Force even after 32 years of development, is powered by US-supplied engines and a flight control system developed by an American company. Similarly, the Arjun main battle tank, conceived 41 years ago, is powered by a German engine and has a gun-sighting system developed by a Dutch firm (since bought by a US company). The list of such examples is far too long.

India has been left behind by China, which was once entirely import dependent on the former Soviet Union. In contrast, India's defence indigenisation capabilities are severely limited and in some areas even non-existent, a fact that is acknowledged by the DRDO. The recent increase in foreign direct investment (FDI) from 26 to 49 per cent may not get the desired results. Foreign companies may not be willing to easily share billions of dollars worth of research undertaken over years. India will have to consciously work towards building brilliance by recruiting and investing in good human resources, involving the private sector more closely and by engaging in joint ventures with friendly countries. Innovative steps are required if the "Make in India" vision has to be translated into reality.

From: ***The Tribune***

Fly in India

Amid a backdrop of daredevil pilots performing hair-raising acrobatic displays at Bengaluru's Yelahanka airbase, Prime Minister Modi's path-breaking 'open for defence business' pitch before representatives of more than 500 Indian and foreign companies is a radical departure from India's past diffidence in opening up the defence sector to what was once decried as the 'foreign hand'. A new focus on private talent and investments is at the heart of the PM's flagship 'Make in India' initiative and he has now outlined a clear roadmap.

Arms imports constitute approximately 60% of India's defence expenditure and Modi is right that this is one area where we do not want to be number one. For a country that spends about $38 billion a year on defence and is set to be the fourth biggest military spender globally by 2020, imports constitute a huge drain on foreign exchange resources. Indigenous defence manufacturing is also crucial for strategic security. India's problem so far has been the sheer incompetence and inefficiency of public sector enterprises. As Modi noted our defence public sector with 200,000 employees needs to do "much better" and be "accountable" but there is enough scope for private companies as well: both Indian and foreign.

At a time when 50-60% of weaponry with our armed forces is obsolete and we are significantly increasing defence spending, there are clear advantages in encouraging private involvement. As the PM pointed out, even a 20-25% reduction in imports could directly create an additional 100,000 to 120,000 highly skilled jobs in India.

Modi is also right in pitching India as a hub in global supply chains. India's technological and engineering talent and relatively low costs make it an attractive prospect for global defence companies if government can get its policies right. The current model where weapons purchased abroad are only assembled on Indian soil, without absorbing technology or developing our own potential, is hugely limiting. With the defence sector contracting overseas, India's emergence as a new production centre will positively impact the economy, beyond just military needs. It will create much-needed jobs, generate significant wealth and can turn India into a base for exports, leveraging as well as strengthening our growing defence partnerships in Asia and elsewhere.

From: ***The Times of India***

Merge the Air Shows

Every two years since 1996, the Aero India Show brings added reverberation into Bangalore skies. Started by the Ministry of Defence (MoD) as a platform for governments and aerospace industries to network and showcase their wares across the world, Aero India is the country's largest military aerospace event. However, given the fact that many aerospace companies span both military and civilian products, there is a civilian element too at the show.

Hundreds of global entities descend upon Air Force Station, Yelahanka, the venue of the event, and people of Bengaluru get an enviable opportunity to witness some world class aerobatics teams, get close glimpses of aircraft not normally seen in Indian skies, and revel in the good fortune to take selfies with all kinds of aircraft and equipment.

Aero India 2015 was highlighted by Prime Minister Narendra Modi's presence to inaugurate the show; inevitably, the observant would discern in his presence the motive of promoting his 'Make in India' impetus. However, the lacklustre response the campaign has drawn so far from international entities are a bleak indication of how much enthusiasm may be manifest during the show about the slogan and the sentiment

RUBIN

behind it. Perhaps, there has not been adequate change brought about by Modi in the business environment in India to alter the perceptions of foreign entities.

Notwithstanding the gloomy prospects for a large quantum of 'Make in India' deals coming to fruition during the show, the substantial presence of international companies is impressive quantitatively. Totally, 54 countries are slated to be represented although of these, only 34 have business representation (the others being only political delegations marking their presence and hoping to gain something from the event). Over 600 companies, nearly half of them Indian, are participating. Of the foreign ones, the US has the highest figure of 64 followed by 48 from France including Dassault with whom the Rafale deal for the purchase of 126 aircraft is simmering over a back burner for the last three years.

There were some irresponsible reports about the possibility of Modi flying in a Rafale during the show but these have been denied. The ongoing conflict between Dassault and the MoD is unlikely to see a resolution during the show despite the presence of Dassault with three Rafale aircraft. Indeed, there were reports of the MoD calling the deal "essentially dead". Needless to say, the Aero India 2015 will provide a platform for competition to re-assert itself through media and lobbying.

The event is expected to receive over three lakh footfalls, double the number recorded at the last Aero India 2013, thus signifying the growing popularity of the show. However, there has been some talk of the venue for the next show being shifted out of Bengaluru. If that happens, it would be a foolhardy and retrograde step. The selection of Bengaluru as the original choice for the show was based on due diligence by the MoD and the Indian Air Force and nothing has changed.

Moreover, crores have been spent over the years on building the infrastructure to support the event; these include an Air Display Viewing Area and an underpass under the Bellary Road to permit connectivity between the parking area and the show venue.

If at all an argument can be proffered for the Bengaluru show to be discontinued, it is the possible merger of the two air shows India hosts biennially - the predominantly military Aero India Show in Bengaluru every even year, and the civilian India Aviation Show at Hyderabad every odd year. Typically for India, the two shows have evolved as a rivalry between the MoD and the Ministry of Civil Aviation which hosts the latter show.

India can ill afford to have two shows and joining up the two would prove beneficial for the participants as well as many of them who end up dividing their show budget over two events in India. Should one show have to be eliminated, people of the garden city would hope that Bengaluru show stays on.

***Gp Capt AK Sachdev in* Deccan Herald**

Budgetary constraints

By many yardsticks, Prime Minister Narendra Modi's trip to three Indian Ocean island nations - Mauritius, Seychelles and Sri Lanka - was a success. It revealed a focus on the seas to India's south and on maritime security that is forward-looking and welcome. These countries have ethnic ties to India, and Mr Modi - as is his wont - stressed India's cultural connections with the hosts and its soft power. But there were also a slew of security-related agreements signed. The problem, however, remains that India's ambitions might be running ahead of its capacities.

In India's southern neighbour of Sri Lanka, Mr Modi's visit came immediately following the remarkable removal by the electorate of the strongman former president Mahinda Rajapaksa. This means that Mr Modi has more space to manoeuvre. Mr Rajapaksa - a man far from popular in Tamil Nadu following his treatment of the Tamils during and after the end of the civil war - has been replaced by an administration that is more willing to talk about the excesses conducted during that war. This means that India's message of reconciliation and devolution is more welcome than it otherwise would have been. Mr Modi made various other promises to Sri Lanka, including the assurance of assistance in developing the island's railways, and the port of Trincomalee.

Meanwhile, in the two other - much smaller - nations, the prime minister had a somewhat more unusual agenda. India signed agreements to build "infrastructure" in two islands - Agalega in Mauritiusand Assumption in Seychelles - that might turn each of those into Indian "strategic assets". Agalega, while part of Mauritius, is actually over 1,000 kilometres north of that country. It is actually a group of two islands, and New Delhi has reportedly wanted the use of the airstrip on the north island for some time. In Mauritius, the behaviour of Britain and the United States in the takeover of Diego Garcia remains a matter of resentment, so India will do well to avoid provoking similar sentiments. It is not known how strongly the prime minister conveyed India's eventual intention to close off the "Mauritius route", the loophole in the two countries' tax treaty that is believed to permit the round-tripping of black money.

The problem in many of these cases is that India's ambitions seem to be running ahead of its capacity. The prime minister may promise assistance to turn Trincomalee into a petroleum hub, but the Sri Lankans will remember that previous attempts to get Indian assistance for development projects foundered on New Delhi's bureaucratic incompetence. And while the plan to develop strategic assets across India's maritime neighbourhood is solid, where is the money to develop a navy consonant with such ambitions? The Cabinet Committee on Security recently approved the construction of seven new frigates; but even then, the first of these ships will come as late as five years - counting from after those currently under construction are finally completed. Money on defence capital expenditure has been pruned. This year, the defence ministry spent only Rs 82,000 crore of the Rs 94,600 crore it had been allocated for capital expenditure. For the coming year, the increase in the provision for defence capital expenditure is considered inadequate to meet the country's needs. Mr Modi's ambitions abroad may run the risk of foundering on constraints at home.

From: *Business Standard*

SAAB

VIEWPOINT

Going slow on defence

Brigadier Gurmeet Kanwal, former Director CLAWS, feels that military modernisation is necessary to meet emerging threats and challenges

While inaugurating the biennial air show Aero India 2015 at Bengaluru on 18 February, Prime Minister Narendra Modi said he did not like the fact that India is the world's largest importer of weapon systems. With the NDA government's second budget approaching, the Prime Minister said in the era of shrinking defence budgets India could, in fact, become a global manufacturing and export hub for arms and defence equipment.

The Prime Minister invited defence MNCs to join hands with Indian public and private sector companies to "make in India" and reiterated the government's willingness to allow FDI in defence beyond the stipulated 49 per cent for projects involving the transfer of cutting-edge technologies. He pointed out that reduction in dependence on defence imports from 70 to 40 per cent in five years would create 100,000 to 120,000 highly skilled jobs, boost investment, reduce costs and upgrade India's manufacturing and system integration skills. In short, a gradual shift in the defence acquisition policy to manufacturing in India will provide huge economic benefits.

In the budget for 2014-15 presented in July 2014, Finance Minister Arun Jaitley had increased the allocation for defence by 12.5 per cent over the amount allotted for 2013-14. The minister had hiked the defence outlay from Rs 2,03,672 crore (Revised Estimates - RE) in 2013-14 to Rs 2,29,000 crore (Budgetary Estimates - BE) for 2014-15. The defence budget, however, now stands at a low 1.74 per cent of India's projected GDP for 2014-15 and accounts for 12.75 per cent of the country's total government expenditure.

While presenting the budget, the Finance Minister had said, "Modernisation of the armed forces is critical to enable them to play their role effectively in the defence of India's strategic interests." However, the increase of Rs 25,328 crore in the allocation - partially neutralised by the high annual inflation rate that still hovers between 6 and 7 per cent, the steep fall in the value of the rupee against the US dollar vis-à-vis the traditional rise in the global prices of arms - was insufficient to give a major boost to the military modernisation that is necessary to meet the emerging threats and challenges.

The total revenue expenditure planned for 2014-15 was Rs 1,34,412 crore (approximately 60 per cent of the budget). This goes towards paying salaries and allowances and expenditure on ration, ammunition and transportation. The remaining amount of Rs 94,588 crore was allotted on the capital account for the acquisition of modern weapon systems and equipment. Various consultancy firms have estimated that India will spend approximately US$ 100 billion over the 12th (2012-17) and 13th (2017-22) five-year defence plans on military modernisation.

The Army has begun raising of the XVII Corps, designated as a mountain strike corps, which is expected to cost Rs 64,000 crore over seven years. Major acquisitions of weapon platforms that have been pending for long include initial payments for 126 medium multi role combat aircraft (MMRCA), 197 light helicopters, 145 ultra-light howitzers, 22 Apache attack helicopters and 15 CH-47F Chinook medium lift helicopters, C-17 heavy-lift aircraft and frigates and submarines. The armed forces must also upgrade their command and control systems and substantially improve their intelligence, surveillance and target acquisition capabilities if they are to become proficient in launching effect-based operations in a network-centric environment riddled with threats to cyber security.

In a letter to Prime Minister Manmohan Singh in March 2012, Gen V K Singh, now MoS External Affairs, had pointed out the 'critical hollowness' of defence preparedness. Ever since the Kargil conflict in 1999, when 50,000 rounds of Bofors artillery ammunition had to be imported in haste from South Africa, the ammunition holdings of the Army have been reported to be too low to fight and win a sustained war. Many other deficiencies in the holdings of important weapons and equipment need to be made up.

While China has been engaged in rapidly implementing new rail, road and airfield projects in Tibet so as to reduce the deployment timings of the People's Liberation Army (PLA) and enhance operational logistics, India's development of infrastructure along the border with China has made relatively little progress. As many as 14 strategic rail projects have been pending due to resource constraints. These shortcomings need to be made up quickly to avoid military embarrassment in a future conflict.

The announcement made in the budget speech to raise the ceiling for FDI in joint ventures (JVs) for the manufacture of weapons and defence equipment from 26 to 49 per cent had fallen far short of the expectations of the defence MNCs. They would have preferred to have a majority stake of at least 51 per cent. That would have made investment in defence manufacture in India worthwhile for them.

The Department of Industrial Policy and Promotion had proposed an increase in the FDI limit in the defence sector from 26 per cent to 49 per cent without the transfer of technology (ToT), up to 74 per cent with ToT, both with FIPB approval, and up to 100 per cent in the case of the transfer of state-of-the-art technologies with prior approval of the Union Cabinet. However, the Ministry of Defence, the defence PSUs and the CII and FICCI, the two powerful of chambers of commerce, had expressed their reservations on giving controlling interest to MNCs.

The Finance Minister had earmarked Rs 1,000 crore for the one rank, one pension scheme. The veterans' associations were not convinced that the allocation of a token amount like Rs 1,000 crore over the full financial year was indicative of good intentions when the actual expenditure was likely to be almost Rs 10,000 crore. As for the government's intention to build a national war memorial at the Prince's Park near India Gate in New Delhi, the three Services have for long sought a war memorial at India Gate and not near it and are disappointed with the decision.

[Rs 100 crore was earmarked but does not appear in the 2015-16 budget; however, it is learnt that "considerable funds" were spent for the short-lived World War I exhibition at Delhi Cantonment in March 2015, which was not well publicised and, indeed, had limited access for the public : Ed]

Boeing

OPINION

Dr Manoj Joshi urges that the Government of India should

Restructure the forces before buying hardware

The 2015-2016 budget shows a provision of Rs 310,079 crore for the defence services. If this looks different from what you read in the papers, it is because it contains a sum of Rs 54,500 crore which is paid out by way of pensions for the defence services, and Rs 8,852 crore which are listed for the MoD secretariat. By a sleight of hand, these are excluded from defence expenditure - but that does not mean they don't come out of the central exchequer.

Buying defence equipment without a plan, won't help our armed forces, as of this just Rs 94,588 crore is for capital acquisitions or new equipment for the services.

Therein lies the dilemma: too much is being spent on pay, allowances, and maintenance of existing forces, and not enough is left over for the ever-increasing costs of modernisation.

And this will increase as the Indian Army expands by another 90,000 personnel in the coming five years, and the Navy and Air Force grow. With the Services demanding top-of-the-line equipment, the question is: can the economy safely absorb the burden of defence expenditure?

In 1978, China's leader, Deng Xiaoping proposed "Four Modernisations" – in agriculture, industry, defence and science and technology – aimed at making China a great power by the early 21st century. We now know that they have succeeded spectacularly. What we may not be aware of is that defence was assigned the lowest priority. The Chinese made sure they became an economic power before undertaking military modernisation which has gotten underway in the last decade.

India's challenge is somewhat similar. Should it commit valuable resources to modernise its armed forces first, or should it get on the path of sustained high economic growth before doing so? India's predicaments are somewhat different. We need manpower intensive forces to police our borders with China and Pakistan, we also need modern forces to deter a rising China whose nexus with Pakistan is only intensifying. How do we factor all this towards a defence policy that is successful and sustainable? Ideally, the Government's national security goals should lead to a formulation of defence objectives which then yield a policy which is implemented.

The first challenge is to have a national security doctrine prepared through interaction between the PMO, Ministry of Defence, Home, External Affairs and Finance. This would yield a strategy paper which prioritise our responses, identify the military capabilities required, as well pinpoint the industrial, scientific, technological and fiscal capacities required to meet the challenges. The problem is that if you ask five Indians what their national security strategies are, you will get five answers. What we need, instead, is an authoritative, official, assessment around which we can make our plans and policies.

Take, for example, external threats. The one area which gets little attention is the Persian Gulf area from which we get 65 per cent of our oil and where 7 million Indians work and send back some $40billion worth of remittances. Yet, for the security of sea lanes from the Gulf and its littoral, we simply depend on 'Uncle Sam'.

The second is to integrate defence planning with national plans – in other words, get the military and civilian *Make in India* programmes to synergise each other. Associated with this is the need to link plans with budgets. The way things happen right now are illustrated by the Government authorisation for the Mountain Strike Corps last year. Such a Corps were not in the Long Term Integrated Perspective Plan (LTIPP) 2012-2017 and hence not budgeted for. The result is the Corps are up by drawing personnel from existing Army units and raiding the war wastage reserves for their equipment.

The third big issue is need for restructuring the apex level management of the armed forces by a) appointing a Chief of Defence Staff and b) creating an expert civilian bureaucracy for managing the MOD. Only then will we get realistic defence plans with proper inter-service prioritisation and which can be synchronised with the defence needs of the country, as well as its resources. Minus this, we get landed in situations where each Service pushes its maximal demand simultaneously, and not having an expert civilian bureaucracy to adjudicate them, these either block each other, or force the Government to take ad hoc decisions.

The fourth challenge is to restructure our armed forces by integrating their functioning. There is no logic in having the Eastern Command of the IAF in Shillong, that of the Army in Kolkata and the Navy in Vizagapatnam.

The Lanzhou Military Region commander, one of seven commands in China, faces five Indian commands—the Northern, Western and Central Commands of the Army in addition to two Indian Air Force Commands. The Services also need to look into their own structures and forces and cut unnecessary manpower and organisations which may have served a function in the past, but are no longer needed. The phased reduction of the Rashtriya Rifles is one case in point. The fifth is to leave behind the colonial heritage of our defence R&D and industry and progressively corporatise/privatise ordnance factories and field workshops. They were needed in 19th and 20th century India but are not required now. In the coming years, budgets and acquisitions should be viewed in the perspective of longer term aims, rather than through bogeys of short-term demands.

Indeed, the Government should hold off making big acquisitions till it can sort out some of the more basic issues. India is a nuclear weapons power and we do not face an existential threat from any state large or small, or for that matter from any non-state actor. Before the Government plunges into the physical modernisation of the armed forces, it needs to put in place the much needed modernisation of the way we think about, plan and manage our national security system.

Buying or making shiny new hardware for the sake of looking modern neither enhances our security – nor helps our economy.

IRKUT

Vayu-on-the-spot Report :

First IAF upgraded Mirage 2000 I/TI handed over

With the two IAF Mirage 2000s forming backdrop in Dassault's clinically clear hanger at Istres, the 'ceremony' marking handover of the first two upgraded IOC-standard Mirage 2000 I/TI aircraft to the Indian Air Force commenced on 25 March 2015 with the address of Dassault Aviation Chairman & CEO, Eric Trappier. Along with him were Pierre Eric Pommellet, Executive VP of Thales Defence Ministry System, the Indian Ambassador to France, Arun K Singh and head of the IAF Programme Management Team, Group Captain KJV Singh.

Trappier referred to the sixty years of Dassault's history in India, involving five different aircraft types, from the Ouragan *(Toofani)* to the upgraded Mirage 2000I/TI. Dassault's Chairman then spoke about the next generation Rafale, "chosen by India in 2012 after a demanding completion" and referred to the recent statement by the IAF's CAS unambiguously wanting a combat-proven and multirole fighter, the Rafale "being a logical step" for the Indian Air Force. Trappier continued that "we are in agreement with the HAL Chairman on sharing production responsibilities" Trappier was emphatic that "considering our conformity with the RFP, I believe that contract finalisation and signature could happen soon". To a pointed question on its status, he said that "95% of the contract negotiations are complete" but could not comment on exactly when the contract would be formalised. He was fully convinced that, as exemplified with this Mirage 2000 upgrade programme involving the IAF, French DGA, French AF, HAL, Thales and Dassault, as well as associated suppliers, such "team spirit" would continue and such foundation pave the way for a much larger challenge, the Indian Rafale programme.

Eric Trappier of Dassault Aviation and Pierre Eric Pommellet of Thales Defence Mission Systems during the handing over ceremony of IAF Mirage 2000s at Istres

Gp Capt KJV Singh, heading the IAF Programme Management Team signing for the upgraded Mirage 2000s. Standing at the centre is Arun K Singh, Indian Ambassador to France

Exchange of documentation for the first two upgraded Mirage 2000 I/TI (aircraft tail numbers KF-107 and KT-201) completed the formal ceremony. After familiarisation flights with the upgraded Mirages at Istres, these will be ferried to Gwalior in mid-April by IAF pilots of No.9 Squadron ('Wolf Pack'), the designated first squadron to receive this type.

Rest of the IAF Mirage 2000 fleet will be upgraded at HAL, Bangalore, with "compete support and involvement of Dassault Aviation and Thales".

[Full story in next Issue].

DAC clears A330 purchase for AWACS-India programme

In its meeting on 28 March, the Defence Acquisition Council sanctioned Rs 5,113 crore (approximately $ 820 million) for procurement of two Airbus A330 aircraft to be adapted as platform for the indigenous Airborne Warning and Control System currently under development by DRDO. The decision has resolved the 'single vendor' situation that had emerged after Boeing declined to offer a platform for the requirement.

The 'AWACS-India' project, as it is commonly known, has already seen significant successes in development of various sub-systems, including the airborne radar itself, and according to Dr K Tamilmani, DG (Aero), only selection of a suitable aircraft platform was required to continue progress on the project (*see item in this issue*). While the overall AWACS-India programme envisages a total of six platforms to be delivered to the IAF, funds for the remaining four aircraft will be released separately, once integration and testing is underway on these first two aircraft.

MoD revives joint DRDO-MBDA SR-SAM programme

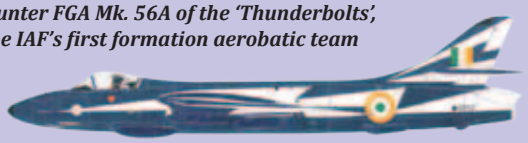
Just weeks before Prime Minister Narendra Modi's first state visit to Paris, the Indian MoD has revived the 'Maitri' Short Range Surface-to-Air Missile (SR-SAM) joint development programme involving the Defence Research and Development Organistation (DRDO) and European missile firm MBDA. Success of the indigenous Akash SAM system, currently in service with the Indian Air Force, appeared to preclude development of another family of missiles, but MBDA remained adamant that the two systems were complementary rather than competitive. Another key element in reviving the programme was that the Indian Navy has found the Akash "unsuitable" for deployment aboard warships.

Maitri will therefore be developed as a ship borne point defence missile, primarily to meet Indian Navy requirements. With the bulk of co-development modalities between DRDO and MBDA already decided in past negotiations, the programme is not expected to take more than three years to fructify after a formal joint development agreement is signed.

IAF to re-establish formation aerobatic team

Although no official announcements have been made, it is understood that the Indian Air Force is to re-establish its famed nine-aircraft aerobatic display team, the 'Surya Kirans,' with HAL-built BAE Systems Hawk Mk.132s later this year. The team, which was disbanded in 2011 owing to a critical shortage of flying training aircraft, originally flew HAL HJT-16 Kiran aircraft in a distinctive orange-and-white paint scheme, and were one of only three aerobatic teams in the world that displayed with nine aircraft in formation.

Hunter FGA Mk. 56A of the 'Thunderbolts', the IAF's first formation aerobatic team



HAL HJT-16 Kiran Mk.II of the 'Surya Kirans'

Established in 1996 as part of No. 52 Squadron ('The Sharks') based at Bidar AFS in Karnataka, the Surya Kirans ('Sunrays' in Sanskrit) displayed with distinction as representatives of the IAF at home and abroad, and were a vital publicity and outreach asset for the Air Force. Such was (and remains) the strength of the Surya Kiran "brand" that the IAF has elected not to rename the team when it is re-established, and to retain the original orange-and-white livery, suitably adapted for the new Hawk aircraft.

Given the difficulty of formation aerobatics, the Surya Kirans will not immediately commence nine-aircraft displays. The team will start practicing basic routines with fewer aircraft, gradually moving on to more complex manoeuvres with more aircraft as skill and confidence grows.

The aircraft required for the Surya Kiran team will be drawn from existing IAF stocks, and will be used exclusively for aerobatic displays. A supplementary order for 20 Hawks is already under process to replace the aircraft that will be taken up by the Surya Kirans. Once the team is back in the air, India will join a number of nations that have chosen the Hawk to represent their excellence in the air, including Finland *(Midnight Hawks)*, Saudi Arabia *(Saudi Hawks)* and the legendary *Red Arrows* of the Royal Air Force. [see cover of this Issue].

HAL hands over 75th Hawk to IAF

Hindustan Aeronautics Limited (HAL) handed over the 75th Hawk aircraft to the Indian Air Force at an event on 21 February 2015. T Suvarna Raju, Chairman, HAL said "we have absorbed the Hawk technology completely and will be able to support the project for next 40 years."

The aircraft is currently being produced at HAL Bangalore under licence from BAE Systems and the first aircraft was handed over to the IAF in August 2008. Air Marshal Ramesh Rai, AOC-in-C, Training Command said that the Hawk has been "of great service" to the IAF and has already flown over 70,000 hours.

T Suvarna Raju, Chairman, HAL (right) handing over Hawk model to Air Marshal Ramesh Rai

Global launch of OIS-AT dual use radars

Union Minister for Civil Aviation, Ashok Gajapathi Raju flagged off the global launch of four OIS-AT dual use radar systems on 19 February 2015. Speaking at the occasion, Raju said, "I am pleased that an Indian defence and aerospace company from the MSME sector has taken the initiative to develop these radars." OIS-AT Chairman and Managing Director Sanjay Bhandari said that he was "pleased that OIS-AT has been able to successfully showcase its R&D and manufacturing capabilities."

The advanced radar systems are designed, developed and manufactured by OIS-AT, and are intended for domestic and global market requirements.

Airbus to collaborate with Indian firms on helicopters

Airbus Helicopters has planned to jointly manufacture military helicopters with Mahindra & Mahindra, Reliance Industries and Tata Group to comply with rules aimed at helping the nascent local defence industry. The company is offering to build its light utility AS550 Fennec and the medium lift EC725 for India's armed forces, which remain dependent on an ageing fleet of Cheetah and Chetak helicopters.

"We are in the selection process, talking to different industries to form a JV (joint venture)," said Rainer Farid, VP Sales and Customer Relations in India, on 20 February.

Last year, the Indian government "scrapped" a planned acquisition of 197 light utility helicopters in order to conduct a new competition with Indian companies bidding in partnership with foreign OEMs. In addition to Airbus, other firms including Sikorsky Aircraft and Russian Helicopters are also expected to bid for the order.

BEL offers indigenous AESA for Tejas

BEL is offering indigenously-built radars for the HAL Tejas LCA programme, which currently uses the Israeli-made Elta EL/M-2032 multi-mode radar. SK Sharma, Chairman and MD of BEL said, "Our Active Array Radar is currently being developed in collaboration with DRDO, and would take two years to complete. Progress is good and we hope Tejas could ultimately have homemade radars."

He also highlighted other programmes underway, such as an airborne electronic warfare suite that is expected to enter trials in six months, and is also likely to be included in the LCA programme. Simultaneously, BEL is developing new tactical control radar for the Army, low-level transportable radars for the IAF and Army, as well as weapon upgrades for the Army.

BEL will also supply key systems for the Akash SAM programme, including long range surveillance radar, fire-control radar, and control systems among others.

Nasmyth committed to *'Make in India'*

Bangalore-based Nasmyth India is currently recording annual sales growth rates of over 300%, which company officials say is "a measure of Nasmyth's commitment" to the government's 'Make in India' capmpaign. Already partnering with manufacturing businesses across the south of India – including Bangalore, Chennai, Coimbatore, Kolar and Hyderabad – for the machining of turned and milled / prismatic components, Nasmyth India is now expanding and further accelerating development of its services to encompass additional engineering capability, a wider range of manufacturing and the introduction of NADCAP approved metal treatment facilities to address needs of the aerospace sector in India as well as globally.

USA "keen on key defence agreements with India"

The issue of India signing three key military interoperability agreements with the USA, earlier rejected by the UPA Defence Minister AK Antony, has come up again, with American officials indicating that they are still hopeful that India will reconsider its stand. The agreements proposed to be signed are : CISMOA (Communications Interoperability and Security Memorandum of Agreement), BRCA (Basic Exchange and Co-operation Agreement) and LSA (Logistics Support Agreement).

Pentagon Under Secretary of Defence for Acquisition, Technology and Logistics (AT&L) Frank Kendall, the US-appointed co-chair for the Defence Technology and Trade Initiative (DTTI), was in New Delhi in February, where he took part in a broad-ranging discussion with a number of military analysts, defence media (including *Vayu*) and representatives from Indian private industry. At the event, he clarified that while there is no connection between DTTI and the three unsigned agreements, the US is still keen to sign the pacts in order to enhance military-to-military interoperability and improve capabilities offered to India by US defence companies.

Anil Ambani's Reliance Group to enter defence arena

The Reliance Group has identified the defence and aerospace sectors as "priority growth areas for the company," and is set to bid for two major Indian military helicopter contracts worth over $3 billion. A Reliance Infrastructure subsidiary has already responded to an RFI issued by the Ministry of Defence, along with other Indian firms such as Tata Advanced Systems, HAL and Mahindra Aerospace. The order is valued at over $1.5 billion and would involve manufacturing helicopters in India with complete transfer of technology.

Reliance Infrastructure is learnt to be actively negotiating for collaboration with noted helicopter manufacturing companies such as Bell, Agusta Westland and Airbus Helicopters. According to a spokesperson, the firm is "set to seize all opportunities offered by the Ministry of Defence to participate in this sector and make 'Make In India' a success."

Defence Minister commits to creation of a CDS post

Defence Minister Manohar Parrikar has said that he was "working on a mechanism" for the creation of the post of Chief of Defence Staff (CDS), an issue hanging and much debated since 2001. The Kargil Review Committee recommended the creation of a CDS among a host of other reforms in the aftermath of the Kargil conflict in 1999, but a series of issues raised by the Services as well as the MoD have so far stymied all attempts to establish the post.

At present the three services, the Army, the Air Force and the Navy, have a Chairman of the Chiefs of Staff Committee on a rotational basis, the post-being held by the senior most among the Chiefs. The minister further clarified that the final decision on his recommendation would be taken by the Cabinet Committee on Security (CCS).

Spanish Defence Minister hopes for more collaboration with India

Pedro Morenes, Minister of Defence of Spain, has expressed Spain's willingness to contribute to the 'Make in India' programme specially in defence-related projects. He said it was 'necessary' to partner and co-operate with India in diverse ways, and specifically mentioned continued interaction between the armed forces of the two countries.

Morenes said he was impressed with the Indian Army's capabilities in mountain warfare, which he hoped could be shared with Spain. He also said that an agreement would be signed with the Indian government for sharing of classified information relating to industry, space and cyberspace, among other areas.

Spain, he noted, would co-operate and partner with India in key areas such as shipbuilding (including submarines) and aerospace (the C-295 as a replacement for the Avro). Spanish company Navantia already has a joint venture with Larsen & Toubro, but Morenes said government-to-government military sales were preferable.

IAF to upgrade Himalayan bases

The IAF is seeking extremely low temperature compatible technology to improve high altitude airfields in Ladakh. This technology, which is used in cold snow-bound areas will facilitate building activities throughout the year and not be limited to the four summer months. While Leh and Thoise are fully operational with the C-17, Il-76, and An-32 and fighter aircraft too are operating there, airfields such as Nyoma and Daulat Beg Oldi are Advanced Landing Grounds (ALGs) and aircraft larger than the C-130J and An-32 cannote operate out of smaller air bases such as Kargil, having a 6,000-foot runway.

The IAF has suggested to the Ministry of Defence that building work only during the four-month warm season – between late May and September – would delay airfield improvement. Thus, technologies used in perennially cold countries have to be adopted to speed up construction in areas such as Nyoma, by working uninterrupted through the winter as well.

What lends urgency to improving and upgrading airfields in Ladakh is the development in western parts of Tibet and Xinjiang province. China has seven airbases in western Tibet and the Xinjiang province, at Kashgar, Korla, Yarkand, Hotan, Cherchen (Qiemo), Ngari Gunsa and Gardzong for fighter operations.

Airbus DS and Kadet collaborate on unmanned target aircraft

Airbus Defence and Space and Kadet Defence Systems (KDS) of Kolkata, have signed a strategic cooperation agreement covering the sale and marketing of services and products in the field of aerial targets.

While the companies will initially offer Airbus Defence and Space's Manoeuvrable Expendable Aerial Target (MEAT) to the Indian Air Force and Army, the new agreement will eventually see them offer further products inside India and also for export. The teaming arrangement lays a roadmap for technology transfer, joint product development, local manufacturing, and provision of joint services in the Asia Pacific region.

BAE Systems awarded Hawk support contract by HAL

BAE Systems has secured a five-year contract worth GBP 18.5 million to provide HAL with a comprehensive package comprising ground support equipment, spares, support and training for the Hawk Mk132 advanced jet trainer, which will aid HAL's plans to establish a dedicated repair and overhaul facility for the aircraft in advance of a major servicing milestone anticipated in 2016.

The agreement was signed at Aero India 2015 between Wing Commander Benjamin, General Manager Overhaul Division, HAL and Steve Timms, Managing Director, Defence Information, Training and Services, Military Air & Information, BAE Systems.

India is the largest operator of the Hawk advanced jet trainer with 123 aircraft ordered to date, of which over 90 have been delivered to the Indian Air Force and the Indian Navy. The Hawks in service have clocked in nearly 70,000 flying hours. BAE Systems has commenced contract negotiations with HAL on a potential order to supply products and services for the manufacture of a further 20 Hawk aircraft. The aircraft, to be built by HAL in Bengaluru, will fulfil the Indian Air Force's requirement for its new aerobatic team.

Maiden flight of LCA Naval Prototype 2

The second LCA Naval prototype (NP2) made its maiden flight at Bengaluru on 7 February, flying for about 35 minutes. T Suvarna Raju, Chairman, HAL said dedicated efforts of engineers from the Aircraft Research and Design Centre (ARDC) particularly on the complex landing gear, which is significantly different from the Air Force version, "was the key."

NP2 was piloted by Captain Shivnath Dahiya of the National Flight Test Centre (NFTC), the launch accomplished under telemetry control exercised by Test Director, Commander J D

Raturi and Safety Pilot, Commodore JA Maolankar, Chief Test Pilot of NFTC. The chase aircraft was LSP2 piloted by Gp Capt Suneet Krishna, the Test Director being Gp Capt Prabhu and the Safety Pilot Gp Capt RR Tyagi.

The ADA LCA (Navy) Programme Office is under Cmde CD Balaji and addresses several systemic deficiencies observed whilst making progress on flight test of Naval Prototype 1, incorporating new avionics. During design and build NP 2 has been customised to incrementally accept modifications for Carrier Landing aids including the Levcon Air Data Computer, Auto-throttle, and Angle of Attack lights. NP 2 is the lead aircraft for arrestor hook integration, the Derby BVR missile and tactical data link.

HAL's Dornier 228 "going strong"

On 28 November 2014, the Government of Mauritius signed a Rs 100 crore ($16 million) contract with HAL for supply of another maritime patrol Dornier 228 aircraft which joins an earlier HAL-Dornier 228 operated by this island nation's Coast Guard. During Aero India 2013, HAL had displayed a Do 228 in markings of the Seychelles air arm.

These modest export successes come amid major domestic orders for the type. In October 2014, the Defence Acquisition Council (DAC) cleared a Rs 1,850 crore purchase of 12 Dornier 228 maritime surveillance aircraft for the Indian Navy which also operates the type in the information warfare role. On 5 February 2015, the MoD placed a further order worth Rs 1,090 crore for 14 HAL-Dornier 228s along with a flight simulator for the Indian Air Force which already has some 40 such aircraft in service including a considerable number for multi-engine conversion training at AFS Yelahanka.

Expeditious delivery of FGFA urged

Following the statement made by Air Chief Marshal Arup Raha during Aero India 2015, the urgency to acquire a fleet of the Fifth Generation Fighter Aircraft (FGFA) from Russia has been placed in focus. The Chief of the Air Staff said, "The future belongs to fifth-generation fighters. Pending issues with Russia will be resolved soon and we will have a compressed timeline for deliveries."

It has been reported that India has suggested that the T-50 fighter be supplied to the Indian Air Force while research to improve upon the aircraft to meet IAF requirements can proceed simultaneously, the same way as was done in the case of the Sukhoi Su-30MKI.

Russia has been insisting on an $11 billion R&D contract for the FGFA project even as multiple prototypes are already flying. India would like simultaneous deliveries of the fighter aircraft to the IAF, a request to which Russia is yet to respond. It has been indicated that deliveries of the T-50 to the Russian Air Force will commence in 2016 and India is to receive 144 aircraft of the type to replace its ageing fleet.

Defence Minister visits Japan and South Korea

As a follow-up to Prime Minister Narendra Modi's visit in September 2014, Defence Minister Manohar Parrikar embarked on a two-day visit to Japan on 30 March and then visited South Korea. Ministry of Defence sources have described the aim of the Japan visit as 'continuation of the dialogue' initiated between the two countries by Prime Minister Modi. The supply of twelve US-2i amphibian aircraft to India by Japan was likely to figure in the discussions during the visit. India's stand on Sino-Japanese dispute over the Senkaku/Diaoyu islands and South China Sea may also have been reaffirmed by the visiting Defence Minister.

INS *Viraat* to be decommissioned in 2016

The Indian Navy has moved to obtain formal MoD clearance to retire the ageing aircraft carrier INS *Viraat* (R22) early next year. The carrier has served for 56 years with two navies, and is the

oldest carrier currently operational in the world. Commissioned into the Royal Navy in 1959 as *Centaur*-class carrier HMS *Hermes*, the ship took part in the Falklands War in 1982 before being sold to the Indian Navy in 1986, where it has served since.

The Navy cited mounting maintenance costs and rapidly reducing availability of Sea Harriers as reasons to decommission the *Viraat*. While the Limited Upgrade Sea Harrier (LUSH) programme bestowed the fighters with improved radar, more modern avionics and beyond visual range (BVR) missile capability, aircraft serviceability has always been problematic, and along with the carrier's own increasing costs of operation and severe reliability issues, has forced the Navy's decision.

However, Navy officials remain sanguine about Indian carrier aviation in general, with the first indigenous carrier, the STOBAR INS *Vikrant* (IAC-1) due to be inducted later in the decade and a larger carrier, IAC-2, being planned for the near future.

DAC approves further orders for PC-7 Mk.II

On 28 February, the Defence Acquisition Council cleared the procurement of an additional 38 Pilatus PC-7 Mk.II trainer aircraft for the IAF, exercising a Rs 1,450 crore option available under the original 75-aircraft order placed in 2012. While the Indian Air Force had projected a requirement for 106 additional trainers from Pilatus, the MoD is clearly reluctant to act against indigenous development and manufacture of aircraft, and ruled out any additional direct purchases. Instead, "the remainder of the IAF's requirement will be met by the indigenous HTT-40 trainer to be made by HAL."

DAC "orders" IAF to procure HTT-40

The DAC has made clear its stance on supporting indigenous programmes and directed the Indian Air Force to order "an adequate number" of HAL HTT-40 trainers to make the project "commercially viable." The IAF has long been reluctant to support the HTT-40, remaining unconvinced by HAL's ability to deliver the aircraft to stated requirements, on time and at affordable cost. However, while this DAC decision may fly in the face of the IAF's protestations, the MoD body has indeed taken note of HAL's past performance issues and will appoint a committee to closely monitor the programme and report all progress to the DAC. Meanwhile, HAL officials are confident that the aircraft will make its first flight later this year and be ready to enter service in 2017-18.

Attrition replacements for IAF aircraft

Among the slew of approvals announced on 28 February, the DAC has cleared a Rs 533 crore proposal to acquire a single C-130J special mission aircraft to replace the No. 77 Squadron aircraft that crashed during a low-level training sortie last year. In addition, the Council also approved procurement of a second-hand French Mirage 2000 trainer to replace a twin-seat IAF Mirage 2000TH that was lost in 2012.

DAC clears revitalised MCMV project

The Defence Acquisition Council has finally cleared a long-standing Indian Navy requirement, for new-generation Mine Counter-Measure Vessels (MCMVs). An earlier RFP was won by South Korean firm Kangnam in early 2011, but remained stalled under the previous UPA government. That contract, worth some $650 million, would have seen two MCMVs delivered from South Korea, with the rest being built under ToT by Goa Shipyard.

When the NDA came to power in 2014, the MCMV programme was among many it opted to close and re-do with a greater focus on indigenisation. The new RFP will require all 12 boats to be constructed in Goa, but still in partnership with a foreign OEM. It is understood that Defence Minister Parrikar's trip to South Korea after Japan included discussions on the MCMV project, which is now worth around Rs 32,000 crore ($ 5bn).

Shinmaywa US-2 decision "deferred"

A decision on twelve Shinmaywa US-2 long range amphibian aircraft for the Indian Navy, much heralded as a key element of increased Indo-Japanese military cooperation, was deferred on 28 February, as the DAC noted that "further discussions" were required regarding the $1.3 bn project.

Indian Navy to acquire shipborne UAVs

According to an Indian Navy Request For Information (RFI) circulated among global vendors, the maritime service intends to acquire ship-based tactical UAVs for "Intelligence, Surveillance and Reconnaissance (ISR), sea-lanes of communication monitoring, coastal/EEZ surveillance, anti-piracy and anti-terrorism, assistance in search and rescue and assistance in maritime domain awareness."

The Indian Navy has stated a requirement for at least 50 such UAVs, and to avoid procedural delays, has refrained from suggesting a narrow set of technical requirements for the launch and recovery mechanisms. This would allow a range of competitors, from the rotary-wing Saab Skeldar and Airbus Tanan to small fixed-wing UAVs such as the Boeing ScanEagle and Textron Aerosonde.

HAL targets mid-2015 for LUH maiden flight

(photo: Angad Singh)

According to company officials, the HAL is targeting a July 2015 maiden flight for the Light Utility Helicopter (LUH) programme. However, even accounting for possible delays, HAL officials are confident that the first flight will not be beyond August. The first LUH prototype has already undergone ground tests, and will continue to do so as the maiden flight approaches. Eventually, two more LUH prototypes will join the flight test campaign, which aims to achieve FOC for the platform in 2017.

The LUH has been developed largely from expertise accrued in the Dhruv ALH programme, but incorporates many new innovations, including a foldable rotor to allow it to operate from Indian Navy warships. In fact, the new rotor will later be adapted for the Dhruv, which cannnot be operated from Indian Navy vessels owing to its present non-foldable rotor. The eventual maritime LUH variant will also incorporate a wheeled undercarriage instead of the skids used for the Army and Air Force variants.

Air Chief: "Rafale and Sukhoi complement each other"

At his press conference during Aero India 2015, Air Chief Marshal Arup Raha, Chief of Air Staff, wearily clarified the IAF's stance on the MMRCA, stating that procuring more Su-30MKIs would not solve the problems facing the Air Force. He said that requirement for the MMRCA is not the same as the requirement that led to induction of the Su-30MKI and that the two "are slightly different – they complement each other but do not replace each other."

At the same press conference, the Air Chief insisted that the IAF's MMRCA requirement was imperative, regardless of the aircraft type selected. "It is important that we have the MMRCA... we need to have the MMRCA in the quickest possible time."

(Detailed report on the press conference in this issue)

DGCA approves HAL as an MRO

The Directorate General of Civil Aviation (DGCA) has accorded approval to HAL's Transport Division at Kanpur for maintenance and repair of Dornier 228 and Avro HS-748 aircraft after a "rigorous audit by a team of DGCA officials."

The Kanpur Division is now a DGCA-approved facility for maintenance and repair of both Do 228 and HS-748 aircraft as per Civil Aviation Requirement (CAR) 145, which was introduced in January 2005 to harmonise requirements for approval of aircraft maintenance organisations with that of international requirements. The availability of type rated license holders in airframe, engine and avionics is a prerequisite for grant of these approvals apart from adequate facilities and documentation for maintenance and repair of aircraft. Since type rated license holders on these aircraft were not readily available for hire, HAL's Kanpur Division undertook DGCA approved courses in 'A', 'C', 'E', 'I' and 'R' categories. An oral-cum-practical test by DGCA was then arranged for award of type rated AME licenses to the personnel of TAD Kanpur.

Indigenous Astra BVRAAM test fired

The DRDO–developed Astra Beyond Visual Range (BVR) air-to-air missile was again successfully test fired by an Indian Air Force Su-30MKI off the coast of Odisha on 19 March 2015.

The test flight had an Astra missile carrying telemetry equipment in place of the warhead being fired from an Aircraft and Systems Testing Establishment (ASTE) Su-30MKI against a Lakshya Pilotless Target Aircraft (PTA) drone. The target was successfully engaged with the test firing captured by telemetry and electro-optical tracking stations. Another successful trial, conducted a day earlier, confirmed the missile's capability to undergo high g-force manoeuvres, to the order of 30 g.

Snecma and HAL sign MoU

Snecma (a Safran company) and Hindustan Aeronautics Ltd (HAL) signed a Memorandum of Understanding (MoU) on 28 January 2015 in Bangalore "to explore establishment of a joint venture in India for the production of aero engine parts." The MoU was signed by Snecma's Bruno Durand, Vice President for Industrial Operations and Supply Chain and Arunachalam Muthukumaraswami, GM Engine Division at HAL.

The proposed JV will initially focus on the manufacture of parts for Dassault Rafale's Snecma M88 engine, then subsequently contribute to other major aerospace projects of HAL and Snecma, "in India and worldwide." Spanning over 30,000 square metres, the proposed new plant is expected to benefit from substantial investment by the two partners, being equipped with state-of-the-art machinery and equipment.

BEL receives CoMPASS order from Elbit

Indian DPSU Bharat Electronics Limited (BEL) has received an order from Elbit Systems of Israel, for production of Elbit's Compact Multi-Purpose Advanced Stabilised System (CoMPASS).

This is in addition to an earlier order for the supply of CoMPASS received in 2014.

BEL has an ongoing Technical Collaboration Agreement with Elbit for joint production and D-level maintenance of CoMPASS for the Dhruv ALH programme. The Israeli firm has transferred necessary technology for production of the CoMPASS in India, and the system is used in the Mk.III and Mk.IV (Rudra) variants of the Dhruv ALH manufactured by HAL.

IAI and Alpha DT in agreement for production of mini-UAS

Israel Aerospace Industries (IAI) and India's Alpha Design Technologies have signed a teaming agreement for the production and marketing of mini-Unmanned Aerial Systems (UAS) in India. The IAI-Alpha cooperation includes IAI's Bird-Eye 400 and Bird-Eye 650 mini UAS as well as other mini-UAS to meet needs of Indian operators.

Production of the systems will take place in India, while the marketing will be a joint effort of the two companies. Integration of additional applications and subsystems will be performed by Alpha in India with IAI's support. Potential operators in India are defence organisations including police forces, the Coast Guard and Border Security Forces (BSF).

New BMS as first MoD-funded 'Make in India' programme

The MoD is set to fund development of a Rs 40,000-50,000 crore 'battlefield management system' (BMS), which is a digital wireless network to interlink soldiers and battlefield sensors through voice and data channels, providing a comprehensive battle picture to each Indian Army soldier. Under the 'make' category of the DPP, the MoD has selected two consortia to develop separate BMS prototypes, and will reimburse 80 per cent of their costs once development is complete. The two teams are a consortium between Tata Power and L&T, and another between Rolta and Bharat Electronics Limited (BEL).

A special MoD 'integrated project management team' (IPMT) will select "the better prototype", and both consortia will then bid for a production contract to build the selected system in quantity for the Army. The 'make' category procedure mandates that an Indian company must lead a project, although it could involve foreign partners. Additionally, a minimum of 30 per cent of the system must be indigenous.

Pawan Hans receives Airbus Helicopters' "Excellence Award"

Airbus Helicopters has conferred an *Excellence Award* on Pawan Hans Limited for this Indian operator's overall contribution to the success of the worldwide Dauphin rotorcraft fleet. As India's national helicopter company, Pawan Hans has logged the highest number of flight hours with the twin-engine Dauphin in India

and the second highest in the world. At the beginning of 2015, approximately 450,000 airborne hours had been accumulated with its inventory of 35 Dauphins, consisting of 18 SA365 N versions, and 17 in the AS365 N3 configuration.

"Pawan Hans is one of most trusted names in Indian aviation today, and its Dauphins serve as the flagship rotorcraft in this operator's fleet, with a proven track record of reliable operations in offshore and onshore sectors," explained Xavier Hay, Managing Director of Airbus Helicopters' Customer Centre in India. "We are committed to continuing the relationship with Pawan Hans, backed by our company's dedication to safety, reliability and efficiency."

Airbus selects Dynamatic as new Tier-1 supplier

Airbus has signed an agreement with Bengaluru-based Dynamatic Technologies Limited to be the single source supplier of flap-track beams for wide body A330 family aircraft. The agreement is the largest manufacturing contract between Airbus and a private sector company in India, and elevates Dynamatic to a global tier-1 supplier in Airbus' supply chain.

Dynamatic has manufactured flap-track beam assemblies for Airbus' single-aisle A320 family on a global single source basis as a Tier-2 supplier since 2010. In phase one of the agreement, Dynamatic will assemble all the Flap Track Beams from its Bengaluru facility. In the second phase, Dynamatic will be responsible for the entire supply chain for the Flap Track including sourcing materials, manufacturing and final assembly. With this new business award Dynamatic will be established as a centre of excellence for the production of flap-track beams.

Sagem and HAL sign agreement

Hindustan Aeronautics Ltd. has signed a technology transfer agreement with Sagem (Safran) concerning the manufacture and maintenance in India of Sagem's SIGMA 95 laser gyro navigation systems. Developed by Sagem for fixed and rotary-wing combat aircraft, the SIGMA 95 is an autonomous, hybrid laser gyro inertial/GPS-Glonass navigation system. It operates in severe environments, "and gives military aircraft a high degree of navigation precision and operational flexibility, thus supporting the success of even the most demanding missions, including in areas without GPS signals."

According to terms of this agreement, HAL will produce SIGMA 95 units for the Indian Air Force, and also provide level 3 front line maintenance. Sagem has further consolidated its partnership with the Indian aerospace industry through this agreement. Several hundred combat aircraft deployed by the Indian Air Force and Navy are currently fitted with Sagem's laser gyro navigation systems, including the Hawk, Jaguar, Tejas, MiG-27, MiG-29 and Su-30.

UTC India affiliate gets FAA approval

The United States Federal Aviation Administration (FAA) has officially approved a product manufactured by the UTC Aerospace Systems affiliate entity in Bengaluru. With this approval, the Bengaluru unit is among the first Indian entities to domestically produce and export an aviation product to aircraft manufacturers in the United States. The approved product is a four-person, compact, lightweight raft which enables passengers and crew in an aircraft to evacuate in case of an emergency landing on water (see above).

"This announcement further supports industry in India by focusing attention on the benefits of manufacturing in-country, and highlighting success of the 'Make in India' initiative to a global audience," added Chris Rao, vice president, UTC Aerospace Systems (India).

Rolls-Royce awards contract to TAL

Rolls-Royce has awarded a contract worth over US $ 19 million to TAL Manufacturing Solutions Ltd., a wholly owned subsidiary of Tata Motors Ltd., for manufacture and supply of precision aero engine components for Trent XWB and Trent 1000 aero engines. The contract will continue until 2022, and has been awarded after a selection process which involved several global companies.

Mr. Kishore Jayaraman, President - India and South Asia, Rolls-Royce, said: "Rolls-Royce is proud to welcome Tata into its family of world-class aerospace suppliers, and we are confident that this partnership will help Rolls-Royce and TAL leverage each other's capabilities. India is rapidly emerging as a preferred destination for sourcing and manufacturing of aerospace components, and companies like TAL have already demonstrated their ability to supply globally by adopting international quality standards, and better efficiency and manufacturing facilities."

Zen Technologies and Rockwell Collins team up

Zen Technologies has teamed up with Rockwell Collins to serve needs of the military flight simulation market in India. The two companies announced their decision to join forces in military flight simulation by unveiling a next generation rotary wing simulator.

The two industry leaders had recently signed a Memorandum of Understanding (MoU) to combine their strengths in simulation and training "to offer advanced and high fidelity aviation solutions. The strategic alliance between Zen Technologies and Rockwell Collins will produce top shelf solutions while also ensuring cost benefits for customers across the region since the alliance's capabilities are indigenised, including software, electronics and visuals. With the rotary wing platform launch, both companies aim to emerge, in the near future, as key partners of the Indian armed forces."

Alpha receives export orders from Elbit

The CEOs of Elbit Systems Electro-optics (Elop) and Alpha Design Technolgies exchanged agreements in the presence of Indian Defence Minister Manohar Parrikar on 19 February 2015, for an export order worth $80 million for manufacture and production of Thermal Imager Fire Control Systems (TIFCS).

TIFCS provides day and night automatic firing capabilities on static and moving enemy tanks and other objects. These high technology systems are not presently in service with the Indian Army but are anticipated to grant a significant improvement in capability once inducted. TIFCS are already being manufactured at Alpha's Bangalore manufacturing and test facilities, in technical collaboration with Elop. An export version of TIFCS will be manufactured by Alpha Design Technologies and exported to Elop in Israel over the next 3 years.

Elbit and Alpha executives exchanging agreements in the presence of Defence Minister Manohar Parrikar

Airbus Helicopters EC130 T2 enters Indian market

Airbus Helicopters has signed Indian launch orders for its single-engine EC130 T2 helicopter with Sanjay Ghodawat Group and Global Vectra Helicorp Limited (GVHL), introducing the popular single-engine EC130's enhanced version later this year for passenger transport services in Kolhapur and Delhi respectively.

"We are delighted that our Indian customers have selected the EC130 T2, which has the largest cabin of any single-engine rotorcraft in the world," said Xavier Hay, Managing Director of Airbus Helicopters' Customer Centre in India. "We are confident the EC130 T2 will provide superior service in this country, especially with its advanced technology and the capability to deliver excellent performance in high and hot conditions."

Xavier Hay, Managing Director of Airbus Helicopters' Customer Centre in India presenting a model of the EC130 T2 to Rudendra Sahu of Sanjay Ghodawat Group

Cold-weather tests for HAL LCH

The second HAL Light Combat Helicopter prototype (LCH TD-2) underwent cold weather trials at AFS Leh during February-March 2015 period. According to HAL Chairman T Suvarna Raju, the trials included engine starts with internal batteries after overnight 'cold soak' at altitudes of 3,000 m and 4,100 m in temperatures as low as -18°C. Engine starts were reported to be "satisfactory" in these conditions. Test flights were also carried out to assess high altitude performance and low speed handling in the demanding Himalayan environment.

Tejas LCA in cold weather trials

The Tejas LCA achieved a programme milestone in January 2015, after completing a series of high-altitude cold weather trials. A test team conducted three consecutive engine starts, without external power, after an overnight 'cold soak' in temperatures of around -15°C. DRDO officials noted that that the test was particularly stringent, as starting the engine three times consecutively requires two of the starts to be conducted with a partially charged battery.

The HAL Aero Engine Research and Design Centre (AERDC), Bangalore has developed the LCA engine starter indigenously, which has been rig-tested extensively prior to aircraft trials. The control software of the starter required modification to work at such operating altitudes, as did the GE F404 engine of the LCA.

Russian Land Forces Chief in India

With the aim of enhancing bilateral military ties between India and Russia, the Commander-in-Chief of Russian Land Forces, Colonel General Oleg Salyukov visited India from 16-19 February 2015. The Russian Chief interacted with General Dalbir Singh, COAS, on 16 February 2015 in New Delhi and later visited the Indian Army's South Western Command Headquarters at Jaipur, as well as the Parachute Training School and Independent Parachute Brigade at Agra.

Exercise 'Garuda Shakti III' in Mizoram

The third 'Garuda Shakti' joint Indo-Indonesian exercise was conducted at Counter Insurgency and Jungle Warfare School in Vairengte, Mizoram from 9 to 21 February 2015. Aimed at building and promoting positive military relations between the two nations, the scope of the exercise included sharing of counter terrorism experience and conducting joint counter insurgency training at the platoon level.

Saab receives IDAS order for ALH

Saab has received follow-on orders from HAL for its Integrated Defensive Aids Suite (IDAS), an electronic warfare self-protection system for installation on Indian Army and Air Force Dhruv Advanced Light Helicopters.

IDAS enhances platform survivability in varied threat environments, providing warning against radar-, laser- and IR-guided threats and automatically deploying appropriate countermeasures. The system is already in operation with the Indian armed forces, equipping HAL Dhruv Mk.IIIs and the armed Mk.IV variant (ALH-WSI, also called Rudra). In addition to the production order, Saab also received orders for IDAS ground support and test equipment for the ALH programme.

L&T to build 7 OPVs for ICG

Larsen & Toubro (L&T) has been awarded a contract valued at Rs 1,432 crore by the Ministry of Defence for design and construction of seven Offshore Patrol Vessels (OPVs) for the Indian Coast Guard (ICG). These long-range surface ships are capable of embarking a helicopter and their roles include coastal and offshore patrolling, policing territorial waters and Exclusive Economic Zones (EEZs), control and surveillance, anti-smuggling and anti-piracy, as well as limited wartime capabilities.In keeping with the Government's 'Make in India' initiative, complete design and engineering of the OPVs is planned to be conducted in-house at L&T's Warship Design Centre. The first OPV under the project is scheduled to be delivered within 36 months from signing of the contract, with subsequent OPVs delivered at six months intervals.

Textron Systems to co-develop PGMs in India

Textron Systems has commenced the process that could lead to co-development and production in India of a new air-dropped precision-guided munition, the G-CLAW. The weapon system is being submitted into the US-India Defence Trade and Technology Initiative, with Textron's intention to have G-CLAW available for co-development and co-production with Indian partners.As the project advances, Textron will seek assistance from the Defence Research and Development Organisation (DRDO) to "identify the most appropriate Indian partners for the venture".

G-CLAW is a 22.68 kg air-launched precision-guided weapon that can be carried on large unmanned aircraft and smaller manned aircraft such as light attack fighters. It can also be deployed from larger military aircraft such as C-130s and converted commercial aircraft using a Common Launch Tube dispenser.

20th Air India Boeing 787 Dreamliner in Star Alliance livery

Boeing and Air India have celebrated milestone delivery of the airline's 20th 787-8 Dreamliner from Boeing's final assembly facility in North Charleston, South Carolina.The new Dreamliner features the Star Alliance livery, becoming the first 787 in the world to don an airline alliance colour scheme. The Indian flag carrier joined the Star Alliance airline network in 2014, and presently operates two aircraft (an Airbus A320 and a Boeing 777-300ER) in the distinctive black and white Star Alliance colours. "The 787 continues to provide great value to Air India, opening new routes, with superior fuel efficiency and unmatched passenger comfort. We are proud that Boeing products continue to contribute to India's growth and modernisation" said Pratyush Kumar president for Boeing India. "We congratulate Air India on their 20th Dreamliner."

Air India serves more than 60 domestic and 37 international destinations. The airline has ordered 27 B-787 Dreamliners, with seven more scheduled to be delivered.

Rolls-Royce to expand engineering capability in India

Rolls-Royce will be expanding its engineering capability in India with plans for a facility in Bangalore that will employ 500 people by the end of 2017. The work done at the facility will include aerospace engineering for customers in the region as well as support for Rolls-Royce's regional supplier base, and will also include the development of new tools and technologies that make best use of the capabilities that exist in India. According to Kishore Jayaraman, President–India & South Asia, Rolls-Royce, "Our plans to expand our capabilities here is testament to India's talented engineering workforce and strongly supports our growth strategy in India. The Government here is fully committed to the development of the aerospace industry, by providing the right infrastructure, talent and a conducive business environment for the industry to thrive."

Rolls-Royce currently operates and manages two engineering service centres in Bangalore: one with QuEST, launched in 2005 and one with TCS which opened in 2010. Both employ around 500 engineers providing engineering solutions and services across the entire product development life-cycle. Further supporting Rolls-Royce's aerospace operations is IAMPL, a 50:50 joint venture with Hindustan Aeronautics Limited (HAL), to manufacture components for the technologically advanced Trent family of civil aero engines in a Bangalore facility that opened in 2013 and employs more than 100 people.

Evacuation of Indians from Yemen

Following a Government advisory in end-March for Indian nationals to leave Yemen owing to the worsening conflict situation in the country, IAF aircraft and Naval ships have been deployed in support of evacuation operations. Indian Navy warships INS *Sumitra*, INS *Tarkash* and INS *Delhi* were engaged along with Indian civilian vessels MV *Kavaratti* and MV *Coral* in bringing evacuees from Yemen to the African Republic of Djibouti.

Meanwhile, IAF Boeing C-17 heavy transport aircraft of No. 81 Squadron have flown to Djibouti from their home base at AFS Hindan, for airlifting the civilians back to India, landing at various cities including Kochi and Mumbai.

HAL board reconstituted: Chairman re-designated as CMD

The Board of Directors of HAL has been reconstituted with effect from 1 April 2015, with the Chairman, T Suvarna Raju re-designated as Chairman and Managing Director (CMD). The revised structure consists of five full time directors, including the CMD, two government nominee directors and seven independent directors. The current position of Director Human Resources is held by VM Chamola, that of Director (Finance) by Dr AK Mishra, while S Subrahmanyan, who was Managing Director (MiG Complex) is now Director (Operations). A new Director Engineering and R&D is to be designated "soon".

The posts of Managing Directors have been discontinued, and instead HAL now has four Chief Executive Officers (below board level). They are V Sadagopan, CEO (Helicopter Complex), R Kaveri Renganathan, CEO (Bangalore Complex), Daljeet Singh, CEO, MiG Complex and Rajiv Kumar, CEO, Accessories Complex.

HAL records Rs 15,480 crore turnover

HAL recorded its highest ever turnover at Rs 15,480 crore (provisional) for the financial year 2014-15 as against Rs 15,128 crore achieved in FY 2013-14. "Our performance is in line with the MoU signed with the Ministry of Defence and we expect 'Excellent' rating for FY 2014-15. The capital expenditure (CAPEX) target of Rs 900 crore has been achieved and we are happy that on the indigenisation front over 2,000 items were produced resulting in savings to the tune of Rs 100 crore," said T Suvarna Raju, CMD, HAL. The operating profit for the year was at Rs 1,560 crore as against Rs 1,551 crore in 2013-14.

As part of Design and Development activities, 384 test flights have been made by the light combat helicopter (LCH) while commercial negotiations have "progressed including internal and bilateral meetings with Russian participation for the FGFA programme". The IJT prototypes have logged 1004 flights so far. Detailed design, jig fabrication and commissioning have been completed for HAL's Basic Turboprop Trainer (HTT-40) and assembly activities have been initiated. The LCA IAF variant has completed 2871 flights of which 364 were during 2014-15, while the naval variant has flown 43 sorties, 24 of them in FY 2014-15. The critical design review for the Mirage 2000 upgrade programme has been completed. Other highlights include handing over of the first ROH Su-30 MKI aircraft and first series production LCA (SP-1) to the IAF, while orders for 14 Dornier 228 aircraft have been placed by the IAF even as production of Hawk AJTs continues.

Saab strengthens its position in Asia Pacific

With effect from 1 April 2015, Saab has appointed Jan Widerström as Country Head and Chairman, Saab India Technology Pvt Ltd (SITL), reporting to President and CEO Saab Asia Pacific, Dan-ÅkeEnstedt. Saab India will become a part of Market Area Asia Pacific as one of the Country Units in the organisation and "will further reinforce Saab's long-term commitment to the Indian market." Jan Widerström has an extensive background in India, previously heading Saab's India operations between 2005 and 2012. Prior to taking over Saab India, he was Head of Major Campaigns at Saab for the Indian market.

The previous Chairman of SITL, Lars-Olof Lindgren, has been appointed as Special Advisor to the President and CEO of Saab in Sweden. With his long experience and extensive network in India, Lars-Olof Lindgren will advise the global management of Saab on business and governmental affairs. Lindgren headed Saab India Technology since 2013, and was the Ambassador of Sweden to India between 2007 and 2012 and will continue to be operating from India.

Admiral Arun Prakash looks beyond

The Budget Blues

Defence Minister Manohar Parrikar seen with Navy Chief Admiral Robin Dhowan and Minister of State for Defence, Rao Inderjit Singh

Such is the Indian politician's lack of interest in matters of national security that the nation's defence budget is rarely, if ever, discussed in Parliament. The fate of the taxpayer's hard-earned money, voted for national defence, therefore, remains a matter of indifference to MPs until the Comptroller and Auditor General opens the musty cupboards of the Ministry of Defence (MoD) to reveal skeletons of financial imprudence or tardy project implementation.

In keeping with this tradition, Parliament has voted, without debate, an amount of Rs 2,46,727 crore (US $ 40.4 billion) for defence for the financial year 2015-16. This amount is dwarfed by the US and Chinese defence budgets of $ 620 billion and $ 180 billion respectively. However, for a nation like India, in which hundreds of millions continue to subsist on less than one or two dollars a day, the defence budget represents a major proportion of government expenditure and warrants our scrutiny – even if Parliament doesn't have the time !

Although the 2015-16 budget represents an increase of about Rs 22,000 crore over the previous year's allocation, it has evoked a general sense of disappointment, amongst defence analysts and military pundits, on a number of counts. Without going into the arcane specifics of budgetary planning let us take note of some areas of concern.

Areas of concern

The first significant point to note is that as a percentage of GDP, the defence budget has dropped from 1.81% in 2014-15 to 1.75% in 2015-16. While this is not the lowest ever, it does represent a steadily declining trend since 2000 when it was 2.31%. The dwindling share of GDP can be ascribed to the greater availability of resources on account of a growing economy. Equally, it may be a disheartening indicator of complacency and the declining priority being accorded to defence in a deteriorating security scenario.

This year's budgetary allocation has grown by only 7.7% over that of 2014-15; which dashed widespread hopes of double-digit growth. A small hike of this nature is a cosmetic gesture because it is neutralised by inflation, exchange-rate variations and annual cost escalations, routinely imposed by all equipment and material suppliers. In real terms, such a meagre increase will aggravate the steadily growing gap between resource requirement and budget allocations; and prolong the stagnation in capital expenditure.

The bad news does not end here. We learn that the MoD in 2014-15 not only failed to spend (yet again) the full amount allocated for expenditure on capital acquisitions but has also allowed the capital-to-revenue expenditure ratio to be skewed to 40:60. Thus we are spending significantly more under the Revenue head (on pay and allowances, stores, repair and maintenance of equipment) than under the Capital head (on modernisation of our fighting forces and acquisition of new capabilities).

There may be more ill tidings for national defence if the recommendations of the 14th Finance Commission, in seeking to re-orient centre-state fiscal relations, reduces the central Government's resource base; but we will not go into that. Instead, we need to look beyond fiscal symptoms, at the deeper malaise afflicting India's national security edifice, because we are living in dangerous times and further aggravation of our existing vulnerabilities could endanger the integrity of the Indian state.

The parlous security scenario

China's geographic proximity and its huge economic and military disparity vis-a-vis India leaves us with no option but to find a *modus vivendi* and even seek economic cooperation till we can find a resolution to bilateral problems. If this was not bad enough, China has made Pakistan the centre-piece of its anti-India grand strategy and by arming it to the teeth with conventional and nuclear weaponry, it has completely skewed the natural balance of power on the sub-continent, placing India in the jaws of a pincer.

The IAF is upgrading legacy fighter types, including the MiG-29, Jaguar and Mirage 2000 (pictured here), not only to enhance capabilities, but also as a hedge against delays in procurement of new combat aircraft

The Machiavellian Sino-Pakistan nexus has not only checkmated India militarily, but also stymied Delhi's ambitions to be a leading Asian power. The display of belligerence by the Chinese and Pakistani armies, during the recent past, conveyed signals of their possible future intent and even the possibility of collusive action on 'two-fronts.' The unforeseen rise of ISIS in the Middle East could have grave implications for India if it spills over into an unstable Afghanistan and a strife-torn Pakistan.

While a totalitarian China, steadily surging forward on the back of a burgeoning economy, is now within sight of great-power status, India's unique brand of democracy has created political conundrums that have impeded progress. The past decade was witness to policy-paralysis, economic slowdown and social unrest, all with long-term repercussions for national security. While the new government is certainly showing signs of greater resolve and vision, its success in policy implementation will depend on how adroitly it manages the turbulent political environment and an obdurate bureaucracy.

Given Prime Minister Modi's proactive focus on foreign affairs, he has used every opportunity to mend neighbourhood fences. He has also reached out to nations and leaders likely to play a role in shaping India's economic and geo-political destiny in the medium–and long-term future. Showing an acute sense of 'realpolitik' Modi has courted both the US and China with gusto. The signs – at long last - seem propitious for the evolution of an Indian grand strategy: modest in scope but coherent in substance.

However, should diplomacy fail and should India's internal and/or external security scenarios take a turn for the worse, our political leadership would expect the armed forces to be combat-ready and prepared for any eventuality. This is unlikely to be the case unless our decision-makers can address five grave lacunae in our security edifice with alacrity.

Addressing security lacunae

Firstly, the time has come for the Indian politician to acquire comprehension of security issues and involve himself directly rather than depending on an ignorant bureaucracy. When Prussian strategist Carl von Clausewitz declared war to be an 'instrument of policy' and a 'branch of political activity' he was placing the onus of responsibility for national security and strategic decision-making squarely on the politician's shoulders. It is time that our Parliamentarians earned their keep by following the example of British MPs and American Congressmen on vital matters affecting national defence.

Secondly, we must know the destination before we can chart a path to it. In the seven decades of independence, neither the Government nor Parliament has considered it necessary that a defence white paper, a national security doctrine on strategy be issued. No government has ever undertaken a strategic defence review or defined national interests and threats. Parliament remains blissfully unaware of the strategic priorities that drive India's military modernisation or the rationale underlying costly investments in military hardware acquisition/development programmes. It is sad that thousands of crores of public money have been squandered on such programmes with no benefit to national security, and without public debate or questioning.

Third, let us educate our security decision-makers. With budgets likely to plateau or even dwindle (in real terms), there is a dire need for prioritising the requirements of weapon systems and other hardware projected by the Services.

Elsewhere in the world, the complex and onerous responsibility of prioritisation is vested in a senior military functionary such as the Chief of Defence Staff on whose advice the MoD undertakes the process of balanced and long-term modernisation of the armed forces. The modality for such an exercise does not exist in India, at least at present.

Whether it is the accretion of an army corps, the acquisition of an aircraft carrier or selection of a combat aircraft, the sponsoring Service must be able to justify its need and relevance against the prevailing threat scenario and economic situation. Military modernisation must be viewed as a continuum in which acquisition choices are exercised across the full spectrum of land, maritime and aerospace warfare capabilities, rather than as decisions taken to meet the aspirations or enhance the prestige of a particular Service. Today, no one in MoD is either qualified or has the authority to pose tough questions to the Service HQs regarding proposed acquisitions.

In the current set-up, generalist IAS officers rarely serve in MoD long enough to gather the necessary experience/expertise regarding military force-planning and equipment-acquisition. Military personnel are marginally better because they happen to be 'users' of the equipment. Consequently, there is hardly a military acquisition programme in India today which has run its course satisfactorily or delivered on time and cost. There is urgent need to impart formal training and create a corpus of experts, civilian and uniformed, well-versed in 'military acquisitions' and 'contract formulation and management' to staff the MoD.

Fourthly, the imperative need for drastic re-structuring of the military-industrial complex must be faced. No country can stake claim to the status of a major power unless it can design and produce a major proportion of the hardware required by its armed forces. In this context, India's failure to attain self-reliance in production of weapon systems must rank as one of the most egregious failures of its post-independence leadership. Starting from almost a similar techno-industrial base in the early 1950s, China is, today, the world's third largest *exporter* of military hardware whereas India remains the world's largest arms *importer*.

While the culpability for this colossal failure rests on two departments of MoD - Defence Production and DRDO - blame must also be shared by the political leadership for allowing defence scientists and bureaucrats to pull wool over their eyes for so long. The first step towards reform would be to split the current all-powerful post of 'DRDO Czar' in the MoD into three separate entities: Director-General Defence R&D, Secretary DRDO and Scientific Adviser to RM; with one of them being a uniformed person. The laudable objective of 'Make in India' can only succeed if the vast resources of the DRDO and Defence PSUs are re-cast on the lines of successful models that exist in the UK, Israel or Singapore.

Lastly, we must create a 'single-point source of military advice' to the Government. Whether it is a Chief of Defence Staff or an empowered Permanent Chairman COSC, he will not only plug a crucial gap in the nuclear command chain, but would also take a holistic view of capability-acquisition/modernisation proposals, and nurture the tri-Service commands and organisations. He would also prepare a 5-10 year roadmap for integration of the armed forces and implementation of the transition to 'theatre commands.' For this measure to succeed, it must be accompanied by creation of joint-Services staffs at the Command level, and professionalisation of the MoD through the substantive induction of uniformed personnel.

Grand National Strategy

The defence budget will have meaning only if it is underpinned by political purpose, and is linked with the implementation of a grand national strategy. This calls for the political leadership to create time and mental space for involvement in national security issues.

The time has come to stop pumping 25-30 per cent of our defence budget into the coffers of Russia, Israel, France, South Africa or USA for purchase of arms and ammunition. Apart from depriving our own economy and industry of these funds, we also make ourselves hostage to these nations in the crucial arena of national security.

All this will only come about if we are willing to take some difficult decisions, and initiate drastic reform in our defence organisations so that we may become masters of our own destiny.

Political leadership needs to be involved when defining the role and necessity of high value strategic assets such as aircraft carriers

The Defence Budget 2015-16

Need to 'Walk the Talk'

Lt Gen Kamal Davar reviews the disappointing Defence Budget 2015-16 in context of India's security situation and urges revision of the allocations in relationship to the nation's GDP.

Situated astride one of the most politically unstable and violent expanses in the world, India confronts diverse and serious challenges to its security and economic well-being. That India has to be prepared to successfully face a two and half front war (China, Pakistan and internal security), either individually or collectively, will be stating the obvious. That combat capabilities based on timely modernisation of weaponry, platforms, equipment, infrastructure et al for building the necessary arsenal, both qualitatively and quantitatively, takes painfully long to accomplish is a well accepted and harsh truism.

Despite India having the third largest standing Armed Forces in the world and having become, regrettably, the largest importer of defence equipment, the combat potential necessary for its Armed Forces to carry out its missions successfully has been slipping rapidly. Apart from bureaucratic sluggishness, lack of decisiveness by successive political leadership, absence of inter-services cohesion and focused planning by services headquarters and tardy procedures overall, the lack of adequate budgeting for the Indian Armed Forces has also resulted in India's security preparedness suffering gravely. Thus the Armed Forces, who were hoping for adequate funding especially this year when the Modi government announced their first full budget for the financial year 2015-16, have been disappointed, to state the least, with the rather meagre and modest allocations for defence.

Overall Outlays

Finance Minister Arun Jaitely, while presenting the Union Budget for fiscal 2015-16, announced an increase in the defence budget by 10.95 percent to Rs 2.46 lakh crore (US$40.4 billion) as compared to the revised estimates of Rs 2.22 lakh crore for 2014-15. While the government had in the previous year allotted Rs 2.29 lakh crores in the budget, this was later revised to Rs 2,22,370 crore. The budget allocation for 2015-16 is Rs 2,46,727 crore with the Revenue Allocation being Rs 1,52,139 and the Capital expenditure pegged at Rs 94,588 lakh crores. The defence budget accounts for nearly 13.88 percent of the total central government expenditure for the year 2015-16, which is Rs 1,777,477,04 crore. Considering the original budget allocation in the last fiscal, this year's budget represents a mere 7.9 percent increase in defence spending.

Defence expenditure has two major components, namely *Capital* which goes towards modernisation by acquisition of newer equipment and *Revenue* which goes towards salaries, pensions and maintenance of the complete wherewithal and assets in place. An optimal mix of both Capital and Revenue Expenditure is endeavoured for and in the Indian context, this ratio of 40:60 is normally considered to be the desired

HAL Dhruv Advanced Light Helicopter of the Indian Army Aviation Corps

equation. However the reality is distinctly different !

Over the years, it has also been observed that notwithstanding such allocations, the Ministry of Defence (MOD) does not fully utilise the capital budget in procuring new equipment. In the last financial year, the MOD spent only Rs 81,965 crore of the Rs 94,588 crore allocated for capital spending. Out of the unspent amount in the capital budget of Rs 12,623 crore, approximately Rs 6000 crore was diverted towards revenue spending like salaries etc and Rs 6,630 crore was returned unspent to the Finance Ministry !

Although overall budgetary allocations are indisputably significant, the MOD's track record in the utilisation of the amounts allocated for capital expenditure, essentially for modernisation, is rather dismal. Only in four of the last twenty years did the MOD get additional funds at the Revised Estimate stage and only once did it fully utilise the allocated Budget Estimate !

It is significant to observe that India's defence budgets, compared to its GDP, is the lowest in the world at merely 1.74 percent and even this has progressively reduced in comparison to its GDP over the years. China spends nearly 2.1 percent of its burgeoning GDP on defence (Chinese official defence expenditure is often understated) and even cash-strapped Pakistan's is over 3.5 percent. Parliamentary committees on defence in India have recommended that India must raise its defence expenditure to some 3 percent of its GDP considering the overall security threat perception.

The expenditure of most nations on defence equipment has been rising exponentially. The US stands at number one with an expenditure of $581 billion followed by China at $133 billion (officially) with some analysts claiming it actually touches nearly $200 billion while India is at the 8th position with its defence expenditure currently around $45 billion annually.

The RSZO 9K58 Smerch rocket system of the Indian Army's 40th Artillery Division

Overall Financial Health of the Economy

The Defence Budget as part of the overall budget for the fiscal 2015-16 comes at a time when certain key indicators of India's economy are on the upswing. *The Economic Survey 2014-15* indicates that the real gross domestic product (GDP) is expected to grow between 8.1 to 8.5 percent in 2015-16 from 7.4 percent in the preceding year. This has helped in the lowering of inflation and the huge fiscal deficit India currently has. In addition, the marked decrease in international commodity prices, especially in crude oil imports, apart from some stability seen in the Rs: Dollar equation will assist India's economy to be in a healthier state. However, despite such clear optimism, whether additional allocations for critical defence needs will be made in the immediate future appears a moot point.

The Defence Budget was also absent on the long standing demand of veterans, namely 'One Rank One Pension' (OROP). The Finance Minister had, however clarified, that "this need not be stated on every occasion. We are completely committed to it." Nevertheless it would have been more than appropriate if the central government had announced this as part of the Union Budget.

14th Finance Commission and its Impact on Defence Spending

The 14th Finance Commission was constituted by the previous government to examine various financial issues for the period 2015-2020 as impinging primarily on centre-state fiscal relations in view of the intended thrust on additional devolution of financial powers to the states. The Finance Commission was tasked to give its recommendations, among many other aspects, to primarily " the sharing of Union taxes, principles governing Grants-in-aid to States for transfer of resources to local

bodies." In addition, it was also tasked with examining the aspect of central government expenditure on defence, internal and border security among other issues. The Defence Budget 2015-16 must also be reviewed in light of the recommendations of the 14th Finance Commission which were tabled in Parliament some days prior to presentation of the Union Budget on 28 February 2015.

The most important recommendation of the Commission, and accepted in principle by the Union government, has been the allocation of 42 percent of the central government's taxes to the states. Thus the fiscal capabilities of the central government will shrink and which can indeed be a cause of concern for the MOD and Services HQ as they are entirely dependent on the Centre for their requirement of resources.

In its submission to the Finance Commission, the MOD had brought to their notice the decline in the defence expenditure : GDP ratio over the years apart from the fact that the MOD has not been able to make necessary newer procurements owing to shortage of funds for capital expenditure. The Finance Ministry had concurred and highlighted the need to increase outlays for modernisation and maintenance of defence assets. The Finance Commission has in fact stated that "Defence expenditure is important and hence resource allocation would have to be done carefully by analysing the competing demands on resources from all sectors, within the resource envelope available to the Union Government." Importantly, they have stated that capital expenditure was beyond the scope of their assessment. Thus it is clear that for future acquisitions of defence needs, the Centre will have to now zealously locate and earmark sufficient additional resources from its overall revenues.

Critically Required Weapon Systems

According to most defence analysts in India, over the years combat capabilities of the three Services have fallen to precariously alarming levels. A review of the so-called 'wish-lists' of the three Services, which has been regularly appearing in the print media, makes for most depressing reading thus mind-boggling ! In their occasional annual interactions with the media, the respective Service Chiefs, have over the years, reiterated most of this 'wish list'.

The Indian Army, which consumes bulk of the defence budget, is actually the worst off as far as modernisation is concerned. Its critical requirements, apart from so many more, include the planned acquisition of nearly 3000 towed and self-propelled artillery/howitzers, Pinaka

T-90S main battle tank on parade

Indian Navy fleet replenishment tanker refuels frigate at sea

Tejas Light Combat Aircraft taking off at Aero India 2015

(Photo: Angad Singh)

rocket launchers, Brahmos missiles, 6.6 lakh assault rifles, armour defeating weapons and anti-tank missiles for its AFV fleet, tactical communication system and battlefield management systems, unmanned aerial vehicles, surface to air missile systems, helicopters for the Army Aviation Corps, apart from development of a Future Main Battle Tank and the Future Infantry Combat Vehicle. Ammunition holdings in various weapon systems must be brought up to the desired levels including war wastage reserves which are currently critically low. And then, the already sanctioned raising of the new mountain strike corps for operations in mountainous regions, will require adequate budgetary support. In addition, infrastructure in the border regions has to be vastly augmented which requires substantial budgetary support.

The Indian Navy, with increasingly wider and critical responsibilities coming its way in the Indian and Pacific Oceans, has to be sufficiently built up in the near future. The Indian Navy envisages a 160-ship force and today sails with 144 vessels. However it is critically deficient in submarines, both nuclear and conventional and somewhat to in missile destroyers and stealth frigates. Adequate budgetary support will be required for developing/extending new naval bases at Rambilli (east coast) and at Karwar (west coast) while enlarging naval facilities in the Andaman & Nicobar Islands. The Indian Navy must factor in the growing Chinese assertiveness in the India-Pacific region and be prepared accordingly even as it provides the necessary maritime muscle to India's "Act East policy."

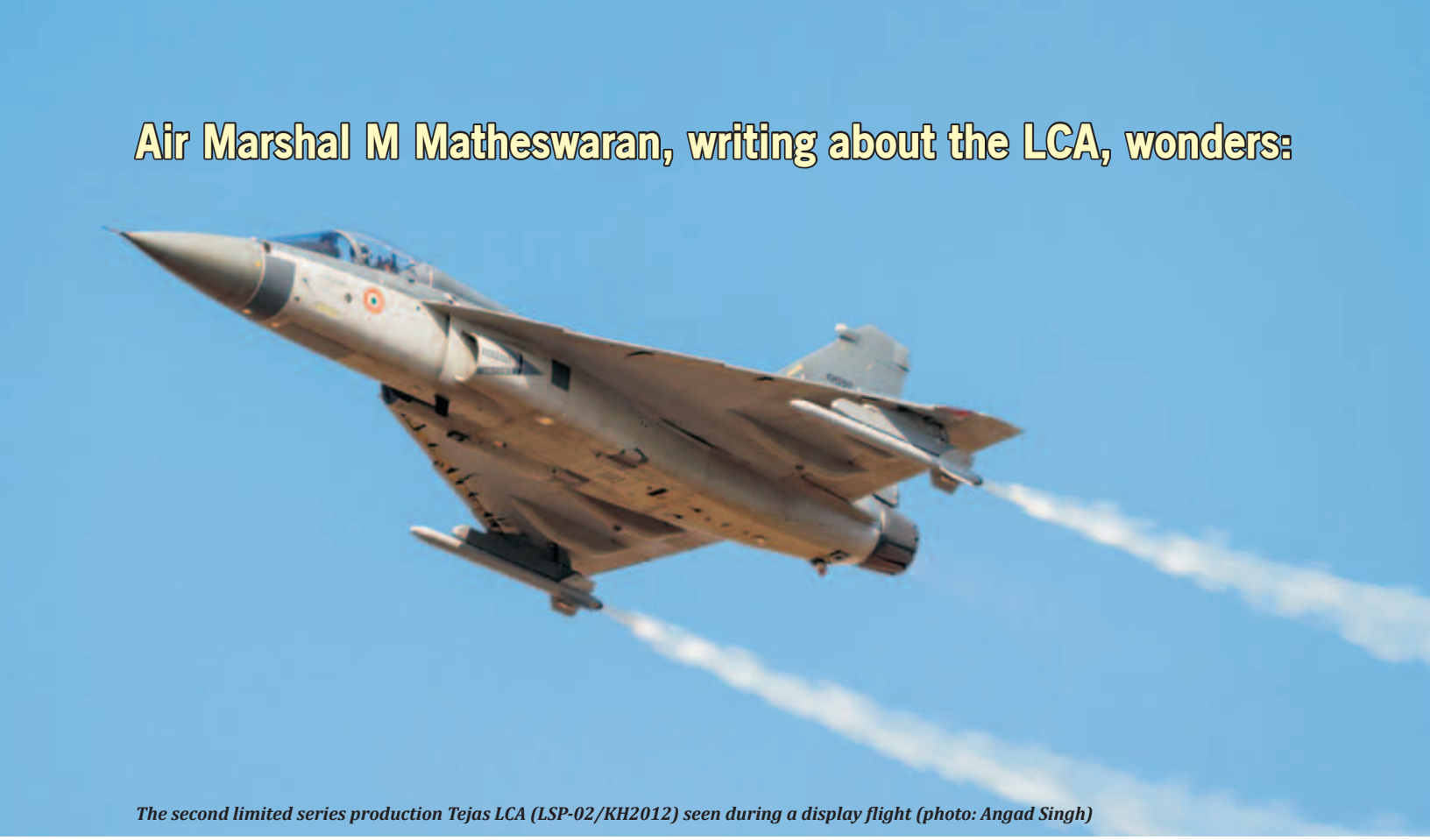
The Indian Air Force's combat capabilities have decidedly taken a serious turn over the last decade with it, currently, having some 35 fighter squadrons operational against a minimum requirement of 42 authorised squadrons (according to the Defence Consultative Committee, the number of combat squadrons was just 25). Another 11 squadrons are likely to be decommissioned before the 13th Defence Plan (2017-2020). Induction of the inordinately delayed and critically required 126 MMRCAs must be expedited by the government. In addition, induction of six squadrons of the indigenously-developed Tejas LCAs, additional numbers of Sukhoi Su-30MKIs, upgrading of Mirage and Jaguar fighters has to be progressed speedily. The fifth generation fighter development project with Russia will also need hefty budgetary support. In addition, the acquisition of 22 Apache attack helicopters, 15 Chinook medium lift helicopters, more C-17 heavy lift transport aircraft is also in the pipeline and budgetary support is obviously warranted.

Collectively, the three Services also require approximately 1000 light helicopters for high altitude logistic support, reconnaissance, command & control, liaison, as also direction of artillery fire plus allied tasks.

At the recent Aero India 2015 in Bengaluru, Prime Minister Narendra Modi outlined his goal to make India a global manufacturing and export hub for arms and defence equipment. He exhorted foreign defence MNCs to synergise their efforts with Indian public and private sectors to "Make in India" and strongly conveyed his government's willingness to allow FDI even beyond the laid down limit of 49 percent. For all this, the Government will have to enforce concrete measures to establish a conducive environment to encourage foreign defence companies majors to establish production units in India even while earmarking sufficient funds for defence R&D and manufacturing as part of a genuine 'public-private partnership' in case it wishes PM Modi's vision to be translated to reality and not remain just great rhetoric.

However, the Defence Budget 2015-16, as presented, does not appear to 'walk the talk' in fulfilling the PM's vision or substantially moving towards India's critical military modernisation imperatives.

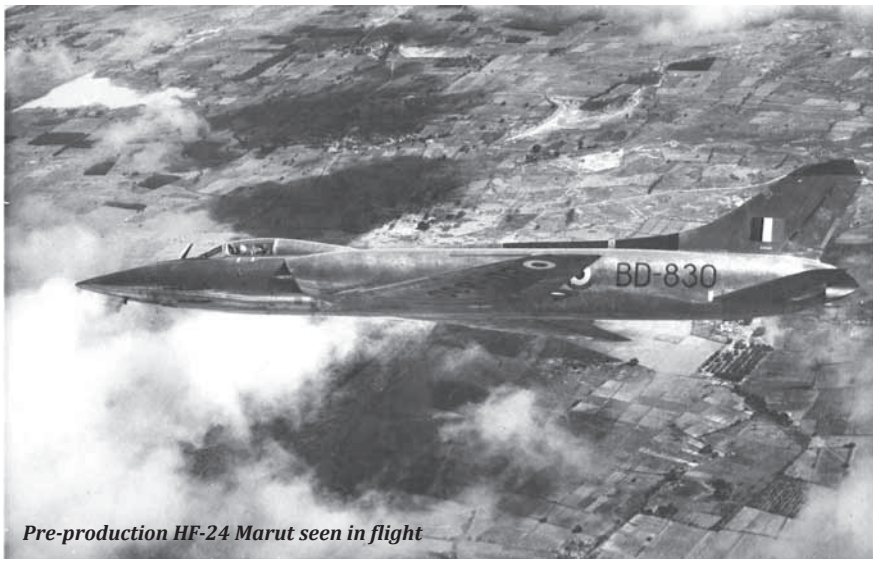
Air Marshal M Matheswaran, writing about the LCA, wonders:



The second limited series production Tejas LCA (LSP-02/KH2012) seen during a display flight (photo: Angad Singh)

Have we lost the plot ?

All major powers, and there are just a handful of them, endeavour to design, develop, and manufacture fighter aircraft by themselves. Ideally, this would include all critical technologies, being the aero engine, aircraft design, metallurgy, radar, sensors, and weapons. However, very few countries have mastery over all these areas of technology. The leaders, or 'early birds,' are the USA, Russia, UK, and France, followed closely by Germany, Japan, Italy and Sweden. The post-1945 world has seen many countries aspire for the same self-reliance in combat aircraft production including Argentina, Brazil, China, Egypt, India, Indonesia, Israel, Iran, South Korea, and Taiwan. Of these, only a few have emerged as reasonably successful late entrants into the aerospace club: Brazil, China, India, Israel and lately South Korea. While China and Israel lead the pack, all of them have built capabilities and strengths in some key domains, but not in all. The most complex challenge involves design and development of aero-engines and aviation-grade materials. Except for China, to a certain extent, none of the others have achieved any meaningful control in these two domains. Simply put, aerospace technology mastery will continue to remain a huge challenge for emerging powers like India.



Pre-production HF-24 Marut seen in flight

Casual follow-through

Aspirations to build an indigenous fighter aircraft began well with the HF-24 Marut programme. In the 1950s, when denial regimes were yet to take shape, India's first prime minister, Jawaharlal Nehru made the wise decision to bring in legendary German

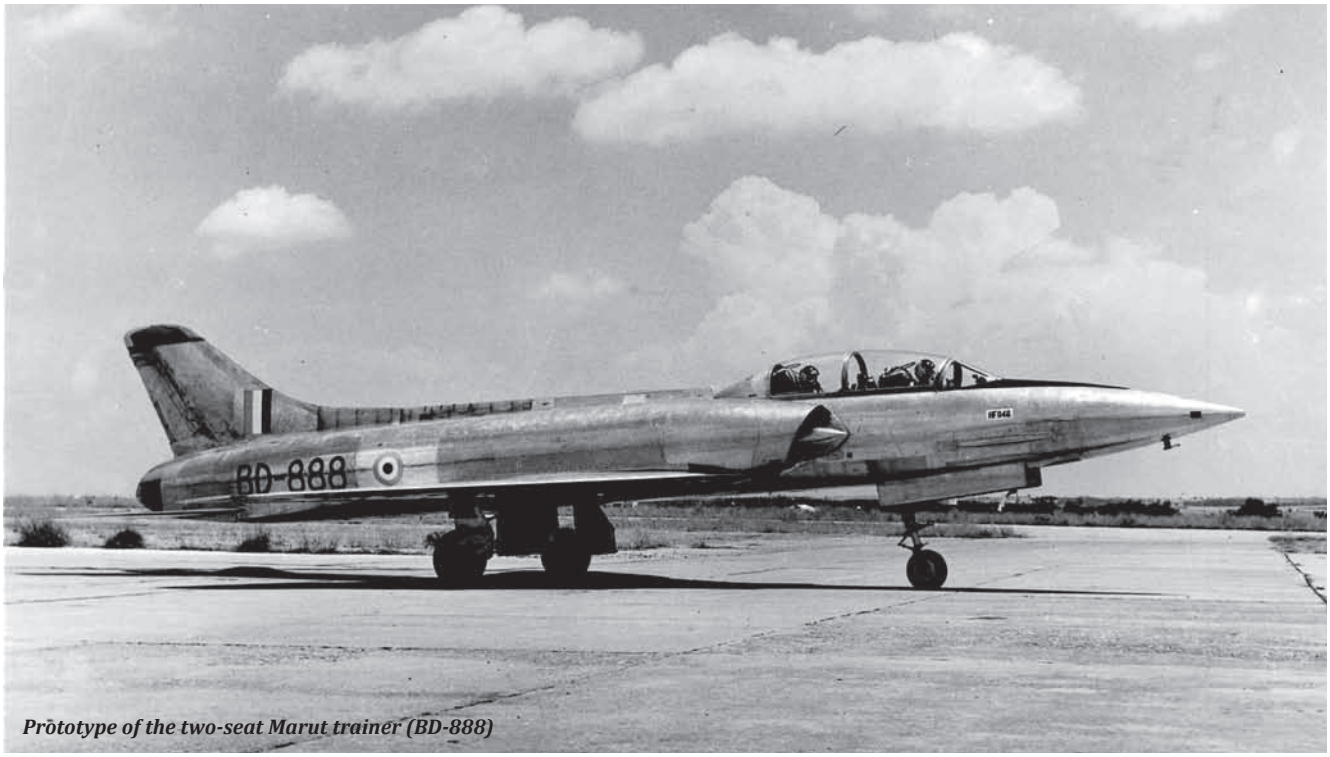
aircraft designer Dr Kurt Tank to head the HF-24 design team. In the aftermath of the Second World War, Tank had offered his services to Argentina, which gladly accepted him. By 1948, he had designed the FMA/IAe 33 Pulqui II, a state-of-the-art fighter for its time. Multiple prototypes were built but its development was cut short by political turmoil in Argentina. That is when he moved to India and began teaching at IIT Madras, before being entrusted in 1957 with the task of designing the HF-24. Until then the only aircraft designed and built by HAL was the HT-2 basic trainer. From HT-2 to the HF-24 was like travelling from Earth to the Moon. The dream was audacious but it became a reality because it was backed by brilliant strategic decisions.

Dr Tank was allowed to bring with him a small group of German engineers to form the nucleus of the final design team, which comprised some 150 HAL engineers by end of the development. The project was sanctioned in 1957, and the first prototype flew in 1961, a mere four years later while the first squadron of series production aircraft went operational in 1967, just six years later! Though handicapped by underpowered engines, the HF-24 acquitted itself well in the strike role during the 1971 India-Pakistan war.

The HF-24 was a brilliant design and a state-of-the-art aircraft for its time. The programme met an untimely demise in 1982 largely owed to short sightedness of the User, Government and Industry. The IAF's leadership displayed singular lack of foresight and national perspective when it decided to phase out the aircraft in 1982, a mere 15 years after induction. The political leadership and the bureaucracy displayed ignorance and strategic blindness over the course of the HF-24's development and operational life. Decisions on engine development with foreign collaboration were shelved under the pretext of it being too expensive; the cost involved was a mere Rs 5 crore! The industry failed to follow a strategy of developing improved derivatives in order to sustain the huge leapfrogging achieved with the help of Kurt Tank's team. The net result was a withering away of precious talent. The 1970s were a lost decade, and HAL shifted focus to licence production of MiG-21s. When the LCA decision was taken in 1983, HAL's design capability was at an all time low. It lost control of the design process and management to the DRDO, which "created" the ADA to "manage" the LCA programme.

After first official flight of the HF-24 : Defence Minister Krishna Menon at the centre seen with (left to right) TS Krishnamurty (Superintendent Prototype Shop), Air Vice Marshal Ranjan Dutt (Managing Director), Dr Bhagwantham (Defence Secretary), Wg Cdr Suranjan Das, KTG lyenger, Dr Kurt Tank, Air Marshal AM Engineer (CAS), Dr Homi Bhaba, SC Das (Chief Aerodynamist), SC Keshu (DTD & P-Air)

The inspiration and the muse : Jawaharlal Nehru and Kurt Tank watch the HF-24 in flight. An ecstatic Nehru exclaimed that the aircraft was like "a gazelle of the air"



Prototype of the two-seat Marut trainer (BD-888)

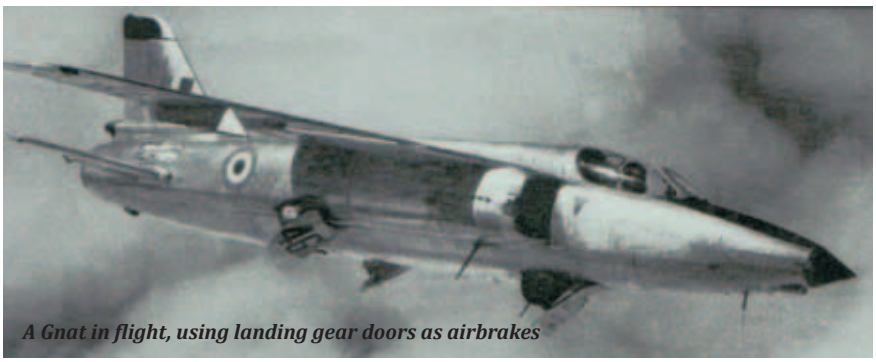
Genesis and flawed decisions

Of late there have been frequent articles written by some self-proclaimed champions of indigenisation and 'Tejas patriots.' None of them know much about aeronautics, leave alone air combat or air strategy and military flying, but continue to comment on how the Indian Air Force must learn to fly and fight any war with the Tejas as its backbone and not pursue hopeless ideas like the MMRCA or FGFA! They would do well to study the LCA programme's genesis, development, hurdles, indigenous content and its true performance in order to appreciate its possible role and potential.

Concept of the light combat aircraft is nothing new. Throughout aviation history, the idea of a 'Light Weight Fighter' (LWF) has been in contention from the point of view of meeting performance requirements at affordable cost. This was feasible in the jet age as downsizing of engines were relatively easier. The Folland Gnat, which the IAF flew successfully in its 1965 and 1971 wars, was a classic lightweight fighter whose performance, in its age, was excellent at minimal cost, although it came at a huge compromise of safety and reliability. Effectively, the MiG-21 has proved to be the most successful lightweight fighter in history. The IAF will have operated large numbers of the MiG-21 for almost six decades once it phases out the last of them by 2020. The focus of the concept of the lightweight fighter has always been 'low cost' balanced by 'acceptable performance'.

The genesis of modern lightweight fighter development goes back to the late sixties which ultimately resulted in production of the most efficient lightweight fighter of the century, the General Dynamics (now Lockheed-Martin) F-16. USAF Colonel John Boyd's *Energy-Manoeuvrability* theory laid the foundation for the lightweight fighter development. This radical new concept was seen as necessary following the poor performance of technologically advanced, heavily armed, expensive and large aircraft like the F-4 Phantom II against low cost, technologically inferior but much smaller and more agile aircraft like the MiG-17 and MiG-21 in the skies over Vietnam. A process of competitive prototype development was adopted. At core of the LWF's design requirement was *performance*. The YF-16, which won the prototype competition in 1972, was the first aircraft to be designed as an unstable platform with fly-by-wire control system and was also the first to use composite materials as structural elements. The rest is history. The prototype programme began in 1971, and by 1978 the series production F-16 was in operational service. Fundamentally, the F-16 programme validated the relevance of balancing technology while keeping performance and low cost as drivers of the programme.

By the late 1970s, the IAF was looking for a replacement for the accident-prone and unreliable Gnat and its Indian version, the Ajeet. The requirement was for a low-cost,


A Gnat in flight, using landing gear doors as airbrakes

The F-16C, modern development of the 1960s LWF programme

conventional aircraft to replace the Gnat/Ajeet and early MiG-21 variants by the late 1980s. Based on its experience with the Gnat and the need for a low-cost fighter, the IAF projected a requirement for a small fighter of 5 tonnes empty weight. This would make the aircraft marginally bigger than the Gnat but smaller than the MiG-21. But this was an inherently flawed approach and indicated that the lightweight fighter concept had not really been studied in depth. This has sometimes been attributed to non-availability of adequate information at that time, but is only partially correct, as HAL did feasibility studies, consulting a number of leading aircraft design firms from western Europe.

After initial studies, the IAF and HAL concurred on a plan for a conventional planform fighter to be developed. DRDO then stepped in to suggest that the fighter development programme be used to bridge technology gaps such as fly-by-wire control systems, airborne multimode radar, aero engines and composite structures. By the mid 1980s this was agreed to and an ambitious plan to develop a fourth generation platform with high performance was submitted to the government. Government approval of the intent was followed by formulation of the ASR (Air Staff Requirement) in line with performance expected of a 4th generation fighter. This is where anomalies in decision-making began to creep in.

To develop a 4th generation fighter within a 5 tonne airframe was a tall order. Even when revised upwards to a 6 tonne empty weight requirement, this remained a difficult task. The projected time frame for completion of development and operational induction of the aircraft in less than a decade was not merely over-optimistic but almost

The Soviet-origin MiG-21MF in Polish colours

foolhardy given state of the technical base that existed with respect to FBW, aero engines, and airborne radars. Starting from scratch, each of these would have required nothing less than two decades of focused research along with significant foreign assistance. Ultimately, two of the major technology objectives were not achieved: the Kaveri engine programme floundered even after three decades of work and has now been declared foreclosed, while the multimode radar did not make any headway and was dropped in 2006 in favour of the Israeli Elta EL/M-2032.

Evocative image of all MiG-21 variants operated by the IAF in formation: a MiG-21 Bison leads a MiG-21bis, MiG-21M, MiG-21FL and a MiG-21UM (photo: Simon Watson)

LCA concept and relevant decisions

The aircraft project was now called Light Combat Aircraft in order to create an identity distinct from the lightweight fighter concept. However, it was evident that the concept suffered from the IAF's fixation with the original idea of replacing the Gnat and MiG-21. Hence, the size and weight limitation remained close to the original idea. These created contradictions in the programme, which the IAF failed to appreciate. By keeping the weight and size at extremely small levels, we were destined to get an aircraft whose radius of action would be no better than that of the 40-year-old MiG-21. Low cost was the primary consideration when deciding to keep the size small, but by introducing high technology requirements this was impossible to achieve. The challenges were about timeframes, cost and performance. Bringing in high technology developments made it inevitable that timeframes would be exceeded by a wide margin. This was either not foreseen or the authorities and agencies concerned refused to acknowledge it. The net result is that the LCA concept, evolved more than three decades ago, is now in question for its very relevance in today's operational and technical environment. Hindsight analysis is always easy as opposed to decision making at that time. However, in development projects it is important to analyse them subsequently in order to learn the right lessons for the future, particularly when the product developed fails to meet the core objectives.

Tejas LCA fitted with drop tanks and close combat missiles

In that context the following questions and observations need to be answered:

- What was the objective when the LCA programme started? Was it to fulfil the operational imperatives of the IAF with a suitable indigenous replacement for its obsolete and ageing fleet or was it national imperative that an advanced fighter aircraft must be made in India? The former is an operational and timeframe imperative while the latter is technology imperative. Why were these two contradicting requirements not addressed?
- Concept of the LCA was to have been based on the successful Light Weight Fighter programme of the USAF. It is now evident that more in-depth research would have helped in defining the size and weight limitations of the aircraft with better strategic foresight and focus on cost. Misplaced beliefs about the Gnat's viability as a low-cost lightweight fighter had overarching influence on the definition of the size and weight of the LCA. Following the AST 201 of October 1983, ASR 2/85 was approved in 1985 after more than two years of deliberations. During this period the IAF was fully aware of the performance, technological sophistication, and operational relevance of the F-16 and Mirage 2000 fighters. Development of the IAI Lavi in Israel should have had significant lessons for us : better research and analysis could have had meaningful impact.
- When the DRDO inserted the need for state-of-the-art technologies to be developed in the LCA programme, why were the timelines not estimated with

reasonable accuracy? That some of the technologies would take nearly three decades to mature, as they finally did, was clear to all, but statements repeatedly indicated that the LCA would enter service in less than decade! These should have been scrutinised in closer detail, which could have led to strategically wiser decisions. To say that these statements were simply errors of judgement would be a gross understatement.

- The IAF repeatedly voiced its concerns regarding the programme but these were overlooked. Secondly, the Air Force's concern about the serious impact in its force structure that a long-delayed LCA would have was painted by interested parties as almost being an obstruction to the national endeavour. The IAF then simply stayed away from the project. This was a serious blunder. The IAF should have convinced the government to grant it full control of the programme, as is done the world over. It is critically important that the user drive the programme in order to balance operational needs and technology development needs.

IAF went along with such decisions when alternate courses of action were available. The HF-24 was a proven airframe but ended prematurely due to its underpowered engines. Considering the fact that the American GE F404 engines were procured for the LCA even before the first prototype was begun, it is surprising that the same engines were not considered as an immediate option to integrate into a revised and upgraded HF-24 airframe. This could have given the Air Force a very viable frontline fighter aircraft that could have entered operational service twenty years ago even while the LCA continued along a realistic development trajectory. Such a derivative-based approach would have been the most logical strategy to follow as the two would have complemented and strengthened the development process. Instead we just allowed the HF-24 experience to fade away.

LCA development : achievements and shortfalls

The LCA programme primarily became a technology development programme team for development, its execution and the final result has all been done in exemplary manner, overcoming enormous challenges. The LCA has a significantly large share of its structures and surfaces made of carbon composite material. The process of developing the required fibres and converting them into the required structures were mastered over a period of time. This is another significant achievement. The Composite Manufacturing Division (CMD) of HAL is truly a world-class facility and addresses the requirement of both the LCA and the ALH (Advanced Light Helicopter) and its derivatives. There are also private sectors players establishing similar facilities to create increased capacity. However, there exists vulnerability owing to import dependence on the raw material (carbon pre-pregs). This is an area where research should have commenced at the same time as the LCA programme.

Other significant achievements are in the areas of system integration, glass cockpit and the mission computer, components development and engineering such as jet fuel starter, accessory gearbox and indigenisation of imported critical equipment such as actuators.

Tejas LCA performs at Aero India (photo : Angad Singh)

- The LCA programme began from scratch. The long period of development and possibility of time delays were inherent in these decisions and should have been foreseen. However, periodic statements over the last 20 years belie such understanding. Given the urgency and priority of the Air Force's requirement it is surprising that the and its operational performance was unintentionally relegated to second priority. As a result there are significant achievements in the technology area but there are serious deficiencies in the performance area.

Development and mastering the digital fly-by-wire flight control system is the most significant achievement of the programme. The concept, forming a national control law

Major technology shortfalls have been the non-realisation of the aero-engine and the multi-mode radar. In spite of major achievements in critical technology areas like the FBW and composites, the LCA as a weapons platform is still critically dependent on imported equipment in areas of power plant, materials, fire control, EW, sensors, and weapons.

Above all, serious shortfalls lie in the area of operational performance. Lack of early focus on operational issues has resulted in poor weight management. As a result the LCA is significantly overweight and cannot meet the thrust to weight requirement in the air-combat configuration. Considering the severe size and weight limitations, it would have been prudent to choose a canard-delta design. Which was also the recommendation of foreign consultants in the early phase. It is strange that this was not followed. Instead we opted to rely on a pure tailless delta design and thought that the combination of unstable platform and digital FBW flight control system would generate enough performance. This was not possible, as subsequent results have shown. Interestingly the Swedish Gripen, which is very similar to the LCA in terms of initial requirement and timing of development and uses the same engine, has a canard-delta configuration, as do the larger Rafale and Typhoon. It is completely clear that one of the reasons as to why the LCA is unlikely to ever fully meet the ASR is owed to the basic choice of the planform design.

The LCA also suffers from high supersonic drag and poor intake efficiency, along with other significant shortfalls in performance related to turn rates, acceleration, top speed and rate of climb. While the aircraft may have excellent flight controls, good sensors and weapons, these critical deficiencies put a question mark on operational relevance of the aircraft. Quite naturally, the IAF would be worried about the LCA's ability to provide required operational capabilities.

Why is India losing the plot ?

Unfortunately, it appears that history is repeating itself. The HF-24, although an excellent design, failed to meet a significant part of its operational requirement – the air defence role – owing to its underpowered engines. Failure to address this critical need was the primary reason due to which the Air Force phased it out prematurely. More importantly, this also resulted in discontinuity in the indigenous fighter development capability. The expertise created from the HF-24 programme was allowed to decay and the LCA work began virtually from scratch.

Given the serious shortfall in performance of the LCA, a focus on its inability to meet the ASR would result in re-living the HF-24 story. Hence, it is important to recognise the larger strategic need, which is consolidation of indigenous fighter aircraft development capability. For this the LCA needs to be factored appropriately, taking into consideration its strengths and deficiencies and here the original US lightweight fighter programme offers the right lessons. That programme focused on developing a lightweight fighter at low cost but with performance as a frontline fighter to complement the more expensive, larger, and technically far superior F-15. This is how the 'Hi-Lo' capability mix evolved. In a similar manner, if the LCA had met the ASR, it would have complemented the more capable but expensive mix of Su-30MKI and FGFAs.

Since there are serious deficiencies in performance, the LCA cannot become the IAF's frontline fighter at the 'Lo' end of the mix, neither can it fill the slot of the MMRCA or its equivalent role. Above all, the IAF cannot afford to look for a one-to-one replacement of its rapidly ageing MiG-21 fleet. India's global profile and security situation of the 1970s and early 80s may have allowed for one-to-one replacement but the nation's increasing stature and global role, its rapidly evolving threat environment, and rapid technological developments around the world necessitate an aircraft with better performance and radius of action in this segment. One can see this with the Chinese equivalent : the JF-17, similar to the LCA, is essentially developed for overseas customers and presently has no place in the PLAAF inventory.

What is the solution?

We must re-strategise on the place of the LCA in the IAF's operational force structure, without compromising on the necessity to continue, consolidate and stabilise India's fighter aircraft industry. This will call for a realistic assessment of the LCA's operational role.

The so-called LCA Mk.II should be seen as the vehicle that should address larger operational radius, better performance and greater indigenisation. It could be a single engine aircraft with redesigned airframe and larger fuel capacity on lines of the Gripen NG or it could be a twin-engine version of the LCA with just incremental technology changes. These options need to be deliberated seriously and success can only be achieved if the industry is allowed to take full charge, with major role for the private industry, and a foreign OEM brought in as a risk-sharing partner and technology provider. This would have the advantage of providing continuity later on to the AMCA programme.

Critically, the need to develop India's follow on fighter aircraft programme must be realised, as this should become the main frontline indigenous fighter for the IAF from the 2030s. For this to materialise, a broader strategy will need to be put in place.

The AMCA project is currently at its infancy, which will allow for many lessons from the LCA programme to be incorporated

"Fearless into Battle"

Enter the Nirbhay LACM

On 17 October 2014 India's subsonic (Mach 0.7), 1,000 km-class, nuclear-capable Land Attack Cruise Missile (LACM) Nirbhay, developed by the Defence Research and Development Organisation (DRDO), made a flawless flight much to the satisfaction of India's military community, opening up multiple tactical options for military operations in the foreseeable future. This was the second test flight of this missile and comes after a first, partially successful flight on 12 March 2013.

At 1005 hours at Launch Complex-3 of the Integrated Test Range (ITR) near Balasore, Odisha, a Nirbhay (which means 'fearless') LACM lifted off from a mobile launcher. Nirbhay's solid-propellant booster engine took the LACM vertically to a height of 800 m when a mechanism in the missile tilted it horizontally and subsequently jettisoned the booster. This was followed by ignition of the turbo-jet engine fed by a submerged air intake and deployment of wings, enabling Nirbhay to cruise at an altitude of 5 km with a 300 kg dummy warhead. It flew for more than an hour traversing more than 1,000 km while progressing from one waypoint to another, covering 16 waypoints on its flight path and even performing steep dives. At the end of the flight, Nirbhay plunged into the Bay of Bengal. All along, a 'chase' Jaguar strike fighter of the Indian Air Force (IAF) tailed it for observation and recording. Subsequently to be fine-tuned by addition of a seeker for terminal guidance to achieve Circular

Error Probability (CEP) of 1-2 metres, the Nirbhay maintained accuracy better than 10 m throughout its flight path. The missile is intended to form a base on which more powerful subsonic cruise missiles with longer ranges will be developed in future by incremental upgrades.

The 8 metre long LACM was designed by the Aeronautical Development Establishment (ADE), Bangalore, a DRDO facility and shares a similar physical profile with the United States Tomahawk and Russian Kh-55 cruise missiles, featuring a slim cylindrical fuselage and a set of folding, pop-out wings for flight control. The Research Centre Imarat (RCI) contributed the primary navigation system comprising the ring-laser gyro inertial navigation system, redundant navigation system and micro-navigation system, control actuators and battery systems. The Research and Development Establishment (Engineers), Pune, another DRDO lab, specifically designed the mobile launcher. The Hyderabad-based Advanced Systems Laboratory of the DRDO contributed the missile's booster motor.

The induction of the Nirbhay LACM in India's Armed Services (with the Navy being the first planned recipient, around 2018) will offer enormous flexibility of military operations both during wartime and in apparent peace troubled by low-intensity-conflicts (including terrorism). Flying at an altitude of just 5 metres-below ground based radar observation, the missile qualifies to be an excellent Suppression of Enemy Air Defence/Destruction of Enemy Air Defence (SEAD/DEAD) weapon, striking at enemy radar and Surface-to-Air Missile (SAM) installations at onset of conflicts when armed with an Anti-Radiation seeker reportedly under priority development by DRDO. The loitering capability will further complicate the defensive mechanisms of enemy's air defence network plus will also be invaluable in decimating relocated terrorist hideouts. A payload of 450 kg is expected, which would include a single high explosive warhead, sub-munitions, or a small (12 kiloton) nuclear warhead.

Sayan Majumdar

"The iPhone of military training aircraft" : Grob's G 120TP

Grob's G120TP is fast becoming the basic trainer of choice across a multitude of Air Forces worldwide, and with good reason. *Vayu's* Angad Singh recently caught up with Grob CEO André Hiebeler for a freewheeling chat about the company's star product and its recent string of successes around the globe.

Nominally based on the firm's piston-engined G120A, which first flew in the late 1990s, the G120TP not only adds turboprop power to the aircraft as the name suggests, but has today evolved into a virtually all-new aircraft. Powered by a Rolls-Royce M250-B17F turboprop engine mated to a 5-blade constant speed MT propeller, the aircraft features a FRP (fibre-reinforced plastic) fuselage, carbon composite wings, and short winglets. The exceptionally spacious cockpit provides excellent visibility, HOTAS controls for both seats, and a full-glass cockpit by Genesys Aerosystems (formerly Cobham Avionics).

Grob's CEO, Andre Hiebeler conveys a quiet forcefulness when talking about the G120TP (he refers to it simply as 'the TP'), as he rightly should. Since taking over the firm in 2008, he has overseen fruition of the G120TP's development and secured significant sales successes for the type, and effectively turned the ailing company around by focusing almost exclusively on the military training market. According to him, Grob is able to offer much more than just a competent military trainer in form of the G120TP. The company, says Hiebeler, offers a full "training system" based around the aircraft, potentially revolutionising the manner in which military flying training is conducted.

Grob CEO André Hiebeler seen in front of one of his aircraft

Flying the G120TP

In the course of 2010 even as the Indian Air Force was sending out RFPs to various international companies on their requirement for Basic Trainer Aircraft (BTA), one such company was Grob at Tussenhausen-Mattsies, south west of Munich which earlier had their G120TP test flown by well known British Test Pilot Peter Collins. His objective was to answer a simple question : could the aircraft challenge a young student while at the same time delivering that challenge in a safe and docile manner ? His experience was recorded in a subsequent *Flight International* magazine article under the heading '*Feels Like a Fighter*.'

"The G120TP represents a "systems of systems" training concept that will revolutionise future military training standards beginning from a student pilot's first day. The G120TP concept offers a level of "embedded frontline simulation" training capability that many frontline air forces currently do not possess, even at the present advanced/tactical stages. The advantages of introducing initial student pilots to a 21st century configured trainer, when they are selected to fly 21st century front line types in a 21st century air force, are, to my mind, immense.

"The first challenge for any air force will be where to set the training boundaries for this aircraft, such is the incredible training potential that its systems will incorporate. The second will be to reassess the role of the flight instructor at this first stage of training given the vast amount of frontline weapon systems simulation and tactical awareness that can be introduced to a student once basic flight techniques have been mastered at the elementary level.

"I feel that the G120TP is a natural complement to the higher-performance - but more expensive -Pilatus PC-21/Aermacchi M-311 flight, attack and systems trainer types and the Aermacchi M-346/KAI T-50/Hawk 128 lead-in fighter trainer types.

"The G120TP comes with such a low purchase price and minimal direct operating costs, but with such high performance and massive training potential for its size, that the complete package seems to me to be amazing value for money within present, cash-constrained defence budgets. Grob still has a busy period as it works towards certification, but it has placed this aircraft at exactly the right spot within the future trainer aircraft marketplace."

Grob executes contracts as complete packages, providing the aircraft, simulators, Cockpit Procedures Trainers (CPT), Learning Management Systems (LMS), and even instructors and mechanics if required.

The new, all-glass cockpit of the G120TP

In essence, the company is able to deliver a comprehensive "training solution" that offers a lot more than the outstanding safety and performance characteristics of the G120TP.

Hiebeler is keen to stress that the G120TP has always been an excellent performer : it climbs at close to 3,000 feet per minute, has benign stall and spin characteristics and is easy to recover from either, and has excellent short-field and hot/high performance. He says that *Flight International*'s test pilot Peter Collins returned from a flight and observed that the G 20TP "feels like a fighter." (see box-item).

To add to that, improvements under the skin have only made it more attractive as a military trainer, and not just for the ab-initio stage. The Genesys all-glass cockpit noted above was certified in December 2014, and features four large 6x8 inch MFDs that present typical primary flight information (PFI) as well as being able to display virtual training routines. Instructors can adapt symbology, simulate failures and replicate a host of tactical scenarios, including an ability to simulate air-to-air radar. Navigation and safety are also greatly enhanced, with a terrain awareness warning system, a synthetic terrain grid display and 'highway in the sky' guidance system.

Hiebeler reckons the G120TP as offered today is "more innovative than any turboprop trainer" on the market and calls it the "iPhone of military training" for its versatility and ease of use. For instance, engine power can be physically limited to around 300 shp for the ab-initio training phase, allowing students to build familiarity and skill before flying the aircraft with the engine at an unrestricted 380 shp (maximum continuous power, absolute maximum is 456 shp for 5 minutes). In the same manner, the multi-function glass cockpit would allow ab-initio trainees to initially fly with only engine and primary flight information displayed,

G120TP seen before delivery to Myanmar

with increasingly complex information being presented as training progresses. The decision to include HOTAS on both seats was a conscious one, as Hiebeler says it allows trainees to get used to the control layout of the frontline fighters they will eventually fly, while having no drawbacks for students that go on to fly transports and helicopters. Hiebeler also highlights the side-by-side seating layout of the G120TP in this regard. The cockpit design is an important part of Grob's training philosophy, as it enables an instructor in the left seat to better monitor a student than in a tandem-seat aircraft. With large numbers of non-fighter aircraft (transport, C4ISR, helicopters and so on) with most air forces, the side-by-side layout is also more typical of the cockpit environments that many cadets will eventually experience when flying operationally.

Being able to accomplish all this in one platform is a major advantage of the G120TP, and has helped Grob offer a revolutionised training pipeline to customers. The present and future of military flying is about "mission management," says Hiebeler. Unlike a few decades ago, when flying military aircraft was a complicated and involved task, today "observing and managing information is the main task" and the G120TP's flight deck environment is ideal to train for this. Given the broad range of performance and simulation available in the platform, Hiebeler believes the G120TP could fulfil a variety of training roles. One possible training pipeline he proposes starts with all cadets conducting ab-initio flying on the G120TP (appropriately limited for the role), before being progressively streamed out for UAV, rotary-wing, and transport conversion. Future fighter pilots would conduct more focused flying on the G120TP, now functioning as a high-performance turboprop trainer, before graduating to the AJT stage and then to lead-in fighter trainer (LIFT) courses. A single training platform being able to accomplish so much, he feels, is an attractive proposition to many customers.

Then, importantly, there is the vital cost aspect – not only is the Grob competitively priced to acquire, it also has incredibly low lifecycle costs. A typical metal-bodied trainer, says Hiebeler, might require as much as two maintenance man-hours per flying hour, translating to a massive maintenance effort across a large fleet of heavily utilised military training aircraft. The G120TP, by comparison, requires less than half an hour of maintenance for every hour spent airborne, granting higher utilisation rates and lower upkeep costs. The composite construction confers further benefits – absolutely no fatigue inspections are mandated for the first 3,500 flying hours of each airframe. In typical usage, that is some five years of flying! By contrast, metal aircraft require regular inspections, some as often as every 50-100 hours of flying.

So low are the upkeep costs and so high the availability and utilisation, that Grob is now confident enough to offer a 'service provision' ("pay by the hour") model, where a military customer does not even need to own and maintain a fleet of aircraft, and can simply pay Grob to make a certain number of G120TPs available for a given number of hours each year, tailored to meet their training obligations. This is the model under which Grob, in partnership with Affinity, was recently awarded a contract for the UK Military Flying Training System (MFTS). Some eighteen G 120TPs will be made available on a per-hour basis at RAF Cranwell and RAF Barkston Heath (in addition to Beechcraft T-6Cs at RAF Valley and Embraer Phenom 100s at Cranwell) for British military fixed-wing training needs. UKMFTS provides a streamlined flight training solution for the RAF, Navy, and Army Air Corps by consolidating all phases of aircrew instruction for the three services through one pipeline, a model that fits Grob's own training philosophy quite closely.

Grob of course has other (more conventional) export customers. Indonesia was the first country to select the G120TP, placing an order in September 2011, and has already received all 24 aircraft contracted for. A follow-on order is expected soon, for a total fleet of around 48 aircraft of the type for the Indonesian Air Force. Argentina was the second country to order the G120TP, and currently operates 10 aircraft.

Myanmar has ordered 20 G120TPs to replace their fleet of Pilatus PC-7 trainers, and deliveries commenced in February 2015. Similarly Mexico has also contracted for G120TPs to replace their PC-7 fleet, placing the largest single order for the type with 25 firm and 15 options. Deliveries for the Mexican order also began in February 2015, and like Indonesia, a much larger fleet of the type is planned. The firm is currently producing around one G120TP every six days at its Tussenhausen-Mattsies plant in Bavaria, Germany, giving it a backlog of around two-and-a-half years (until end-2017).

With successes in Europe as well as the competitive Asian and Latin American markets, Hiebeler is confident that his company can maintain momentum and add new customers for the G120TP as well as expand upon existing operators of the type worldwide. The company's lean structure gives it a distinct commercial advantage, and Hiebeler remarks that Grob can be "quick and flexible" in executing orders. He is understandably pleased with the firm's recent string of successes, and is rightfully optimistic about the future.

Beyond an Air Show

Prime Minister Narendra Modi flanked by the Ministers of Defence and Civil Aviation, Chief Minister of Karnataka and other dignitaries on stage at Yelahanka, 0900 hrs, 18 February 2015

PM exhorts 'Make in India' !

Almost two decades after the last Prime Minister of India inaugurated the Aero India Show (Deve Gowda in 1996), came the present Prime Minister Narendra Modi, to Yelahanka on 18 February 2015. Within minutes after his VVIP Boeing 737 touched down at AFS Yelahanka, the PM joined the Defence Minister and other dignitaries on the novel, mobile stage for inauguration of Aero India 2015. There were to be many other 'firsts' at this Tenth edition of the Show.

However, unlike past occasions, the Prime Minister did not go through various 'traditional' ceremonies, including lighting the lamp or being profusely garlanded but even as three Mi-17s trailing flags flew past, got down to business. The brief welcome speech by Defence Minister Manohar Parrikar was followed by that the Chief Minister of Karnataka, before the Prime Minister made his inaugural address to the invitees, seated this time on tiered stands unlike the loosely arranged furniture in yesteryears.

The Prime Minister went straight to the point, stating "this is the largest ever Aero India and reflects a new level of confidence within our country and global interest." However, Mr Modi quipped that, although "India is a major business opportunity" it also has the reputation of being the largest importer of defence equipment in the world. Although this would be "music to the ears" of some gathered there, it was "one area where we would not like to be number one!"

The Prime Minister speaking at the inaugural of Aero India 2015 (photo: Angad Singh)

That India has to equip itself for defence needs of the future, as also for managing internal security the Prime Minister stated that "we are increasingly integrating technology and systems." For him, Aero India was not just a trade fair for defence equipment, but a mega meeting involving some of the world's leading global supply chains and one involving "the most advanced technology and complex equipment."

Prime Minister Modi was of the firm belief that a nation with a strong defence industry would not only be more secure, but that immense economic benefits would also accrue, boosting investments, expanding manufacture, supporting enterprises, raising technology levels alongside increasing economic growth in the country.

India's defence industry in the public sector, employs nearly 200,000 personnel, including thousands of engineers and scientists, with an annual output of nearly $7 billion, this also supporting a very large number of small and medium enterprises. However, participation of the private sector remains glaringly small, and leads to the situation where that 60% of India's defence equipment needs are is imported, accounting for tens of billions of dollars.

Mr. Modi suggested that even with 20-25% reduction in imports, this would directly create an additional 100-120,000 highly skilled jobs in India. Further, "if we could raise the percentage of domestic procurement from 40% to 70% in the next five years, we would double the output of our defence industry." The Prime Minister enthusiastically continued, "Imagine the impact in terms of jobs directly created and that in the related manufacturing and services sector!" He referred to indirect benefits for other sectors in terms of working

Up and away ! Forklifts remove the 'mobile' stage after the inaugural speeches

with advanced materials and technologies, making it important that India focus on developing its defence industry with "a sense of mission". He emphasised that "this is at the heart of our '*Make in India*' programme," and reiterated that governments support for the defence sector was essential, while there should be a degree of assurance on orders.

Prime Minister Narendra Modi with Defence Minister Manohar Parrikar watching the flying display

Air Chief Marshal Arup Raha with General Dalbir Singh and Minister of State for Defence, Rao Inderjit Singh (partly hidden), Minister of Civil Aviation, Pusapati Ashok Gajapathi Raju and Defence Secretary RK Mathur

The Prime Minister announced a scheme to provide up to 80% of funding from the Government for development of prototypes in India and creation of a Technology Development Fund. Mr. Modi went on to state that procedures would be simplified, mooting expansion of the private sector's role even in major programmes so as to enhance "national capacity". He felt there was "new excitement in our small and medium sector" and gave an example of Dynamatic Technologies, which company began manufacturing critical parts for the Boeing Chinook helicopter, "a day after Make in India was launched" *(see item in this issue).*

The Prime Minister declared that a "new era" for the defence industry in India has begun, but ended on a lighter vein, saying that "as we look at these wonderful aircraft and enjoy the amazing flypast, I also hope we can get some business done and sow the seeds of successful new ventures and partnerships, to give our people new opportunities, to make our nations safer, and the world more stable and peaceful."

Let the Show begin !

Thereafter the Prime Minister and other VIPs left the stage to join special invitees at the VIP enclosure to witness the ensuing air display, but first were treated to the incredible scene where two forklifts from R.E Rogers, who are now virtually synonymous with Aero India and other defence exhibitions, simply lifted and then moved the stage off in a smart display of efficiency. View of the runway was now clear and the air show began, somewhat diffidently with a vintage Tiger Moth performing a series of sedate manoeuvres but this was quickly eclipsed in both power and spectacle by the Tejas LCA display, piloted by Gp. Capt. Suneet Krishna (*see item in this Issue*).

After the roar of the LCA's GE404 had subsided, HAL's LCH TD-1 in 'Tigerbird' livery, with HAL Chief Test Pilot (Rotary Wing) Wg Cdr Unni Pillai at

Lord Astor of Hever, DL, Britain's Parliamentary Under Secretary of State, Ministry of Defence with the British High Commissioner and Russian Ambassador to India

Tejas light combat aircraft on display

the controls, carried out a dramatic demonstration with some manoeuvres more suited to fixed-wing aircraft than a helicopter!

Shortly after he brought the Tigerbird back to *terra firma*, twin Saturn AL-31FPs rent the air, powering Wg Cdr Karulkar and Flt Lt Navjot Singh skywards in their Su-30MKI of No. 106 Squadron. As if to outdo the incredible presentation of aerobatics by the LCH, the Sukhoi display was conducted low, fast and loud, with the pilots showing off the aircraft's super-manoeuvrability and post-stall controllability with signature moves such as the loop-tumble-yaw and tail slide.

Once the Indian military aircraft had completed their displays, a series of civilian show teams were given freedom of the skies. The Breitling Wingwalkers of the UK were first, with wing walkers Freya Paterson and Nikita Salmon carrying out a series of heart-stopping gymnastic poses atop a pair of impeccably restored Stearman biplanes in orange-and-white livery. They were followed by Jacob Holländer of the Scandinavian Airshow team in his 'Viking' custom-built single-seat aerobatic biplane, who put on an impressive solo display, highlighting the incredible power-to-weight ratio of his aircraft. Holländer was followed by the Yakovlev Aerobatic team, comprising three Yak-50 single-seat monoplanes led by Jeremy Hopkinson in a two-seat Yak-52.

Sukhoi Su-30MKI of No.106 Squadron 'Lynx' shows off its super manoeuvrability

As the nostalgic drone of piston engines faded, the jets started up once again, and US Air Force Captain Austin Brown took first off in his F-16C of the 13th Fighter Squadron 'Panthers' for a fast and furious display, highlighting the power and agility of this fighter.

The final jet demonstration was the much-awaited Dassault Rafale, in the hands of Rafale Solo Display Pilot Capitaine Benoit 'Tao' Planche who made quite an impression on the audience, conducting most of his manoeuvres at low level and in afterburner !

HAL's light combat helicopter (LCH) firing its smoke generators

With no fixed wing aerobatic teams in attendance this year, the *pièce de résistance* of the inaugural flying display was provided by the Indian Air Force's Sarang helicopter display team, flying four peacock-liveried HAL Dhruv ALHs. The Sarangs performed up to their usual excellent standard, wowing first-time attendees with precision and incredible close formation flying, providing a fitting finale to the displays.

It was now time for business !

Lockheed Martin F-16C of the USAF 13th FS 'Panthers'

Dassault Rafale B of the Armee de l'Air's Escadron 3/30 'Lorraine'

Dramatic cross over by Dhruvs of the Sarang formation display team

(All photos by Angad Singh)

Time for Business !

PM visits HAL display, surveys Aero Engine, LCH

After the inaugural ceremony and flying display, Prime Minister Narendra Modi was conducted around the exhibition halls and static aircraft park at Yelahanka. He expressed considerable interest in various HAL products and programmes, especially the HAL turbofan engine project and light combat helicopter. HAL Chairman T Suvarna Raju reviewed these programmes : "the medium thrust class engine will find wide application in military trainer aircraft, smaller regional jet and unmanned aerial vehicle applications."

The PM was also briefed on HAL's Light Combat Helicopter (LCH), which is expected to receive initial operational clearance (IOC) and enter Limited Series Production (LSP) "shortly".

To encourage technology development in India, the Government has set up a Design & Development Management Board (DDMB), under the chairmanship of HAL with members from DRDO Labs, Department of Defence Production and the Services, for synergising R&D efforts within the country.

HAL hands over BrahMos-integrated Su-30MKI to IAF

HAL handed over the first BrahMos missile-integrated Su-30MKI to IAF at a special event on 19 February at Aero India 2015. "This is a proud moment for HAL. The successful completion of the first Su-30 aircraft integrated with BrahMos missile shows the synergy between DRDO, HAL and IAF. We are hopeful of rolling out the second aircraft in a record time," said T Suvarna Raju, Chairman, HAL. SK Misra, CEO and MD, BrahMos Aerospace Pvt. Ltd. was present at the occasion.

The Flight Clearance Certificate was handed over by Dr. K Tamilmani, DG (Aerospace) to the DCAS Air Marshal SBP Sinha, while the Aircraft Acceptance Certificate was handed over by to Air Marshal Sukhchain Singh, the AOM.

HAL showcases Light Combat Helicopter

(photo: Angad Singh)

Third prototype (TD-3) of HAL's Light Combat Helicopter (LCH) is seen above coming in to land at Yelahanka on 16 February. This rotorcraft is described by a HAL test pilot as "very close" to the eventual production standard, and differs from the first two prototypes in having a shorter forward fuselage with re-profiled nose area, along with modifications to the canopy. All that remains is to install and test a fairing for the THL-20 gun turret and an infra-red suppression system (IRSS) for the engine exhausts. Meanwhile, *Vayu* was informed that TD-2 was currently in Leh for cold weather trials (*see news item*).

String of orders for HAL's Dornier 228

RUAG Do 228NG on static display at Aero India 2015 (photo: Angad Singh)

On 28 November 2014, the Government of Mauritius signed a Rs. 100 crore ($16 million) contract with HAL for supply of another maritime patrol Dornier 228 aircraft which joins an earlier HAL-Dornier 228 operated by this island nation's Coast Guard. During Aero India 2013, HAL had displayed a Do 228 in markings of the Seychelles air arm.

These modest export successes come amid major domestic orders for the type. In October 2014, the Defence Acquisition Council (DAC) cleared a RS. 1,850 crore purchase of 12 Dornier 228 maritime surveillance aircraft for the Indian Navy, which also operates the type in the information warfare role. On 5 February 2015, the MoD placed a further order worth Rs. 1090 crore for 14 HAL-Dornier 228s along with a flight simulator for the Indian Air Force, which already has 40 such aircraft in service, including a considerable number for multi-engine conversion training at AFS Yelahanka.

Curiously, at Aero India 2015, Swiss Firm RUAG displayed its Dornier 228NG aircraft, featuring revised avionics, uprated engines and composite five-blade propellers. The fuselage and wings, however, are built at the same production line in Kanpur where HAL builds 'legacy' 228s for Indian and foreign customers. While HAL continues to notch sales with Dornier 228s coming out of Kanpur, the 228NGs offered by RUAG have had no notable export success.

Also at Aero India, HAL revealed that it was working on its own in-house set of upgrades for the Dornier 228, which includes an all-glass cockpit and uprated engines which would compete with RUAG's version which is reportedly far higher in price.

A HAL-built Dornier 228 flying test bed, recently delivered to DRDO, seen arriving for static display at Yelahanka (photo: Angad Singh)

Minister for Civil Aviation, Ashok Gajapathi Pusapati Raju, seen with SK Mittal, General Manager (Business Development, HAL) at the Company's Chalet. Mr Raju was reportedly briefed on HAL's Dornier 228 light transport aircraft programme and the Minister expressed the need for connecting the 'hundreds of unused airfields' in India to increase air connectivity particularly in rural areas

The HAL Dornier 228, built at Kanpur, can carry 19 passengers and has excellent short take off and landing performance which makes it ideal for flying to hitherto unconnected airfields throughout India and particularly in mountainous terrain and offshore islands

Lt General PK Bharali, who has recently taken over as Director General Army Aviation, was at Aero India 2015 where the Directorate also had an exhibition stand in Hall 'D'. Army Aviation is expanding its inventory with increasing numbers of HAL-produced helicopters including the Dhruv ALH, Rudra and has placed orders for considerable quantity of the light combat helicopter

HAL Dhruv Mk.III advanced light helicopter of Army Aviation (photo: Angad Singh)

With large model of the US-2i in the foreground, Commodore Sujeet Samaddar, Director and CEO of Shinmaywa in India, is seen with visiting Indian Navy and Army Officers. Also visiting the only Japanese industry stand at Aero India 2015 were Admiral RK Dhowan, Chief of the Naval Staff, Mr Amitabh Kant, Secretary IPP and Chairman India – Japan Joint Working Group, Lt General AK Ahuja, DCIDS (PP and FD), Vice Admiral RK Pattanaik Deputy Chief of Naval Staff, Maj Gen UK Gurung, ACIDS PP, Major General Takanori Hashimoto, Director, Logistics Department Air Staff Office (Japan), Dr Satish Chandra, of NAL and Indian Coast Guard Team lead by DIG DR Sharma, Principal Director Aircraft Acquisition

Dynamatic produces first Chinook Aerostructures for Boeing

Bangalore-based Dynamatic Technologies Limited has produced the first set of aft pylon and cargo ramp assemblies for Boeing's CH-47F Chinook helicopter. Boeing and Dynamatic's commitment to 'Make in India' was highlighted by Prime Minister Narendra Modi during his inaugural address at Aero India 2015 in Bengaluru.

"In a competitive world where our customers are increasingly demanding more for less, this delivery is a milestone that demonstrates the capability we are scaling-up with our supply-chain partners, right here in India," said Pratyush Kumar, President Boeing India. "We set up a new assembly line with Dynamatic Technologies soon after the Prime Minister formally launched the 'Make in India' programme in September 2014. Going forward, our participation will continue to accelerate with support from government and our industry partners", remarked Kumar.

"The production of major aerostrucutres for Boeing's CH-47F helicopter is a major accomplishment, and is a significant milestone for the Indian aerospace industry" stated Udayant Malhoutra, CEO and managing director, Dynamatic Technologies Limited. "We are proud of our partnership with Boeing, which has invested considerably in development, training, tooling, and quality systems working closely with us in establishing advanced manufacturing capabilities in India, which is truly in consonance with the 'Make in India' programme.

"The Chinook is an advanced helicopter requiring complex manufacturing processes, and this Make-in-India capability demonstrates that Indian companies can deliver high standards of quality and productivity within a competitive cost structure that is essential for the aerospace sector," said Dennis Swanson, Vice President, Boeing Defence, Space & Security India.

Udayant Malhoutra, CEO and MD Dynamatic Technologies Ltd during interaction with Vayu at Aero India 2015

Dynamatic's relationship with Boeing began in 2010 with the award of a contract to supply mission and power equipment cabinets for the P-8I maritime reconnaissance and anti-submarine warfare aircraft. In 2013, Boeing placed its first CH-47 Chinook helicopter contract in India with Dynamatic for aft-pylon and cargo ramp assemblies.

Boeing awards titanium forging contract to Bharat Forge

On *Day One* of Aero India 2015, Boeing announced a multi-year contract with Bharat Forge of India to supply titanium forgings for wing components for the Next-Generation 737 and 737 MAX.

Under the agreement, Bharat Forge will begin supplying pre-machined forgings from its facilities in Pune and Baramati to Boeing in the first quarter of 2016. The titanium parts will be heat-treated, shaped in a forging press, and machined by Bharat Forge before being shipped to Boeing Portland for finish machining into components. The components then will be installed in the Next-Generation 737 and 737 MAX wings at the Final Assembly plant in Renton, Washington.

"This contract demonstrates our accelerating engagement with Indian suppliers to scale-up aerospace manufacturing aligned with the Prime Minister's 'Make in India' initiative," said Pratyush Kumar, president, Boeing India.

"The partnership with Boeing highlights our capabilities in titanium forging and our unwavering commitment to offer high end technology and tangible value in the aerospace sector," said Kalyani. "We have mastered the stringent process requirements for titanium forgings and will be supplying critical forgings for wing components in one of Boeing's high volume products. This also confirms our resolve to meet the aspirations of the 'Make in India' drive."

Boeing at Aero India 2015

A look at the 'Boeing Enclave' at Aero India: in the foreground are an F-15D from the 44th FS and the VP-45 P-8A Poseidon, with a second F-15D, a KC-135R and C-17 parked behind (photo: Angad Singh)

American participation is often among the most visible and enthusiastic at Indian defence shows, and Aero India 2015 was no different. As is becoming the norm the US Air Force sent a single Boeing C-17 and a pair of 13th Fighter Squadron F-16Cs to conduct daily flight displays, but what was truly striking was the scale of the Boeing footprint at the show! In addition to the aforementioned C-17 airlifter, the aircraft on static display included a US Navy Boeing P-8A Poseidon from Patrol Squadron VP-45 'Pelicans' based at NAS Jacksonville in Florida, a pair of McDonnell Douglas (now Boeing) F-15D Eagles from the 44th Fighter Squadron 'Vampire Bats' and 67th Fighter Squadron 'Fighting Cocks' based at Kadena AFB in Japan, and a Boeing KC-135R from the 909th Air Refueling Squadron also based out of Kadena.

When all the aircraft were parked together at the easternmost end of the static park, the area was a veritable 'Boeing enclave'! There was no doubt that showgoers appreciated the aircraft on display, as well as the particularly friendly and engaging demeanour of the American personnel in attendance at this edition of Aero India.

The C-17 displayed its impressive capabilities on every day of the show (photo: Angad Singh)

Rafale International at Aero India 2015


(photo: Angad Singh)

Rafale International, the consortium consisting of Dassault, Thales and Snecma (a Safran subsidiary), showcased three Rafale fighters at Aero India 2015. One single-seat Rafale C was on static display (between Hall E and AB), while two twin-seat Rafale Bs were earmarked for flying at the show, with Capitaine Benoit Planche, callsign '*Tao*,' performing one solo display each day. Notably, the Rafale C on display at Yelahanka had been participating in an active combat campaign as recently as one week before the show! It last conducted an anti-ISIS air strike on 9 February 2015, before flying directly from the combat theatre to Bangalore for the air show. In fact, it was still 'dusty'!

"Dassault Aviation has proudly contributed to India's defence preparedness for more than 60 years. Demonstrating Rafale's capabilities in Aero India is reaffirming Rafale International's support to India's sovereignty. We have had a long standing relationship with the Indian Air Force and industry and will continue to partner India in meeting its strategic defence and economic needs," observed Eric Trappier, Chairman and CEO of Dassault Aviation.

BAE Systems showcases commitment to 'Make in India'

Encouraged by Prime Minister Modi's call to 'Make in India', BAE Systems' at Aero India 2015 extended their commitment to a range of platforms and technologies. Building on the success of its flagship programme in India, the Hawk advanced jet trainer, the Company's Pavilion emphasised the continued development of Hawk's training, performance and operational capabilities. Marking the Company's progress in partnering Bharat Electronic Limited in the country's first 'Make India' programme, Tactical Communications Systems, the pavilion had a dedicated section on the "Internet for the Battlespace" or secure, deployable broadband voice, data and video communications systems.

India is arguably the largest operator of the Hawk advanced jet trainers with 123 aircraft ordered to date, of which over 90 have been delivered to the Indian Air Force and the Indian Navy. The Indian Hawks in service have logged over 75,000 flying hours. BAE Systems has commenced contract negotiations with Hindustan Aeronautics Limited (HAL) on a potential order to supply products and services for manufacture of a further 20 Hawk aircraft. The aircraft, to be built by HAL in Bengaluru, will fulfil the Indian Air Force's requirement for reforming the *Surya Kiran* formation aerobatic team.


Hawk AJT of the IAF

Making its debut was the Advanced Precision Kill Weapon System (APKWS) rocket. Developed as a highly cost-effective solution that leverages the military's existing infrastructure and inventory, the APKWS rocket turns a standard unguided 2.75inch (70 millimeter) rocket into a precision laser-guided rocket to give warfighters a low-cost surgical strike capability. Currently in its third year of full rate production, the APKWS rocket has been successfully demonstrated on more than a dozen fixed-wing and rotary-wing platforms including AH-64 Apache, the F-16, the Bell 407, and the AH-1W. Building on in-theatre success by the US Marines, the APKWS rocket has been chosen by Jordan for its CASA 235 light gunship aircraft.

The Company's exibition at Aero India 2015 had an array of equipment targeted towards India's rapidly expanding military helicopter inventory. This included the S3000 and Mission Adaptable Crew Seats (MACS). The Striker helmet-mounted display (HMD) too was displayed at the Show. Now in service on the Eurofighter Typhoon, the Striker provides "comfort, protection, and helmet stability for both fixed- and rotary-wing platforms such as the Light Utility Helicopter (LUH), Apache and the Light Combat Helicopter (LCH)."

Thales : partnering India's Armed Forces

Model of Dassault Rafale at the Thales stand in Hall 'AB'

Thales has been actively partnering with the Indian industry and proactively sharing knowledge, technical know how and expertise for several decades. Taking this mandate forward, the company has created a partnership with HAL and has joint ventures with Samtel, BEL and L&T Technology Services. In addition, Thales has also been developing its local supply chain with 15 small businesses in India.

"Thales is vigorously looking at increasing its industrial footprint in India to develop talent and initiate innovations." The company aims to expand locally in India through its own wholly owned subsidiary *Thales India Private Limited,* its JVs and all the partnership with the local industry that can be envisaged.

With an enviable history of innovation and excellence, Thales is a global technology leader in the areas of defence, security, aerospace, space and transportation. Since 1953, Thales has had presence in India and is recognised today as a reliable partner by both the Indian Armed Forces as well as the civil sector. With an objective to significantly develop its industrial footprint in the country, the company has been actively partnering with Indian industry and seeks to realign its solutions and industrial footprint according to local needs, and has over 300 employees across the country.

Since 2011, Thales and Dassault Aviation have worked together towards upgrading the IAF's Mirage 2000 fleet, the first of which made its maiden flight at Istres in October 2013. The upgrade will significantly enhance the IAF's air potential by extending operational performance of the existing Mirage fleet and taking full advantage of its capabilities, as a result of which, the IAF will have coherent platform-system combination for the next 20 years. The IAF's air potential will be further enhanced by the integration of new capabilities which include longer-range-weapon firing against multiple targets simultaneously, weapon stealth and extended operating envelope with the capability to engage ground targets while countering airborne threats.

OIS-AT Air Defence Systems 'made in India'

With ongoing efforts to usher in the latest defence technologies, OIS Advanced Technology have entered into technology collaborations with foreign firms to function as Indian OEM for advanced Air Defence Systems (ADS) to meet select military requirements in India. These technology collaborations will have OIS-AT bid for the successor to the Bofors 40mm L/70 air defence gun of the Indian Army, and the Close In Weapon System (CIWS) and Pechora upgrade programmes of the Indian Air Force.

Commenting on the development, Sanjay Bhandari, Founder Chairman & Managing Director of the OIS Group of companies said, "OIS Advanced Technology has been working for some time now with our European technology partners and have entered into a number of collaborations as the India OEM to bid for and subsequently manufacture these sophisticated systems in India. The manufacture of these proven technology systems in India will advance our vision of the Government's 'Make In India' initiative."

As the exclusive Indian OEM for these leading technologies and in view of the significant expansion of its 'Make in India' drive, OIS-AT proposes to set up new manufacturing facilities within the financial year 2015-2016. The investment, which will be in a phased manner, is currently anticipated to be in excess of Rs 500 crore and will be led by OIS-AT and its consortium partners. Manufacturing will include various gun systems and its components, in addition to radar systems. Further, it plans to establish an advanced line for the upgrade of the Pechora Air Defence system to meet requirements of the Indian Air Force.

Safran India showcases its capabilities

At Aero India 2015 Safran displayed the M88 turbofan engine that powers the Rafale multirole fighter, and the Shakti helicopter turbine which was co-developed with HAL for the Dhruv twin-engine rotorcraft. The company also displayed a wide range of products that include the AASM (air-to-ground modular missile) Hammer, BlueNaute, a "maintenance free" solution for maritime navigation, and explosives and narcotics detection technology handheld and desktop devices : Mobile Trace, Hardened Mobile Trace and Itemiser.

Present in the country for over six decades, Safran employs over 2,600 "skilled workers" in India. Amongst the group local activities, Safran has a 50/50 venture with HAL, exporting 100% of its production of aircraft / helicopter engine parts. The Group exports more than 60% of the 1 million smart cards produced daily at its Noida Plant. Safran also develops leading edge aerospace equipment in its engineering services centre with 700 engineers at Bangalore.

"Stronger onus on research and development will be the way forward for Safran India." The recent collaborations with the *Foundation for Innovation & Technology Transfer* (IIT, Delhi) and *Society for Innovation & Development* (IISc, Bengaluru) are steps taken to initiate R&D in the field of advanced avionics systems for the development of next-generation aerospace technologies in India.

As Stephane Lauret, Chief Executive Officer of Safran India, said, "We have been present in the Indian market for over 60 years and have focused on product development in India. As we continue to strengthen our presence in India, we are working with our local partners to shape the future of India's aerospace, defence and security industries."

IAI MLM delivers 1000th EHUD AACMI Pod

Israel Aerospace Industries (IAI) has marked delivery of its 1000th EHUD AACMI pod, an advanced Autonomous Air Combat Manoeuvring Instrumentation Training (AACMI) System.

The EHUD AACMI system is a technology enabler for LVC (Live Virtual Constructive) training, and provides a significant advance in the performance of modern joint training capabilities for air, ground and naval forces. The use of on-board systems enhances the effectiveness of live training, reduces expenses and helps increase operator familiarity with the systems.

At Aero India 2015 IAI presented a model of the EHUD derivative, HTS, a Helicopter Training and Safety System, intended for attack helicopters. "It enriches live helicopter training by offering high-value embedded pilot training with maximised safety features. HTS provides high-fidelity simulation for helicopter weapons and tactical flight training in a hostile environment that includes live and virtual early-warning (EW) threats."

IAI has developed a unique R-73 AACMI derivative, which has been integrated into various fighter aircraft of the Indian Air Force. The IAI AACMI R-73 configuration is the only AACMI pod available in an R-73 missile enclosure.

As Yoav Tourgeman, IAI/MLM Division's General Manager said, "Delivering the 1000th EHUD system to our customer marks an unprecedented importance of this advanced product and reflects a high degree of customer satisfaction, more than 20 years since its initial introduction."

Rolls-Royce highlights commitments at Aero India 2015

Rolls-Royce presented its 'Partnership with India – Past, Present and Future' exhibition at the Aero India 2015 show at Yelahanka, showcasing its products and services. The Rolls-Royce stand at Hall B featured three examples of its propulsion systems: the Adour, which powers the Hawk trainer, the Trent 700 from the Airbus A330 tanker aircraft, and the C-130J's AE2100 engine.

"We are delighted to be a part of Aero India 2015, the most prestigious event for the defence and aerospace industries in India," said Kishore Jayaraman, President, Rolls-Royce India and South Asia. "We believe that Aero India offers a significant platform to further expand Rolls-Royce's business opportunities in the defence sector. The event will allow us to demonstrate to India how our long-term commitment to the country, combined with our innovative technologies, makes us the natural 'Make in India' partner."

Steven Gillard, Vice President, Customer Business – Defence, Rolls-Royce, added: "India and Rolls-Royce share a common desire to grow and develop the Indian aerospace industry. This desire is built on a successful partnership that has seen Rolls-Royce working together with India's Armed Forces since 1933. Rolls-Royce is helping to drive the indigenisation of the Indian defence industry through our strong in-country partnerships. We are also committed to delivering the government's 'Make in India' vision that aims to position India as a global manufacturing hub. We are excited about Aero India and are honoured to be part of one of the most significant events in the global defence calendar."

Saab's Carl-Gustaf M4 System at Aero India

FFV Ordnance, part of defence and security company Saab, presented the newly developed next generation Carl-Gustaf M4 for the first time in India at Aero India 2015. The Carl-Gustaf M4 is the latest man-portable shoulder-launched multi-role weapon system from FFV designed to provide users with flexible capability and help troops to remain agile in any scenario.

The Carl Gustaf M4, weighing less than 7 kg, offers significant weight savings to the soldier. It is also compatible with future battlefield technology such as intelligent sighting systems for programmable ammunition.

With a wide variety of munitions available, it is a weapon system capable of handling multiple tactical situations, bridging the gap between full-scale operations and low intensity conflicts, and providing the modern warfighter with unprecedented flexibility and capability on the battlefield.

"We are very proud to present the new Carl-Gustaf M4 at Aero India for the first time. It has been developed as a response to the evolving needs of our customers and we are very pleased to show the new capabilities to such a distinguished audience," said Bo Thörn, head of FFV Ordnance.

Carl-Gustaf M4 is the evolutionary next step in multi-role, man-portable weapon systems. It can be taken into any combat environment and used effectively in a variety of strategically useful ways. The M4 design and capability enhancements were showcased to a selected group of visitors at a ground combat systems demonstration held in Sweden last September. The demonstration included a comprehensive series of successful firings with a range of ammunition types against a variety of targets.

Israeli Defence Minister inaugurates Israel Pavilion

Israeli Defence Minister Lt Gen Moshe Ya'alon, along with the Ambassador of Israel to India, Daniel Carmon and Director General of the Defence Ministry Dan Harel, inaugurated the Israeli pavilion at Aero India. The pavilion, one of the largest national displays at Aero India 2015, was organised by SIBAT, Israel's Defence Cooperation Authority. Over fifteen leading Israeli defence firms were enthusiastic participants at the show, eager to demonstrate their high-tech products.

Among the systems on display at the Israeli pavilion included air defence systems, UAVs, satellite models, missiles, aircraft self-protection suites, EW systems, and other unique technological solutions developed by small- and medium-scale Israeli startup companies.

Speaking at the inauguration, Defence Minister Ya'alon said, "I am proud to be the first Israeli defence minister to visit India. We see this as a sign of the deepening of relations between the two countries; not only in defence but across many sectors." He also welcomed Prime Minister Modi's 'Make in India' initiative, saying, "During my visit we will examine with the Indian government the concept of 'Make in India' in order to produce some products in India. We're very flexible and we are here to address Indian needs."

Defence Minister Ya'alon (centre) cutting the ribbon at the Israel National Pavilion (photo: Angad Singh)

Ya'alon also met with his Indian counterpart Defence Minister, Manohar Parrikar on the sidelines of the Air Show and discussed Indo-Israeli cooperation in the defence sector.

Controp's MICRO-STAMP at Aero India 2015

Controp demonstrated its recently introduced MICRO-STAMP dual sensor day/night stabilised miniature payload for small UAVs at Aero India 2015. With a low weight of only 300 grams, this advanced gyro-stabilised miniature payload is also now being supplied to the first customer.

According to Johnny Carni, VP Marketing at Controp, "Following meticulous research and development, we are demonstrating 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."

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.

IAI's array of technologies at Aero India 2015

Israel Aerospace Industries (IAI) displayed a variety of cutting-edge defence solutions at their stand in Hall 'A'. IAI, Israel's largest aerospace company, has an important emphasis on fully-operational solutions for multi-purpose use in the air, on land, at sea, in space and in the cyber arena. The company showcased special mission aircraft, Unmanned Aerial Systems (UAS), a variety of sensors and radar systems, air defence systems, satellites and advanced cyber solutions, missiles, command and control solutions and electro-optical payloads for intelligence, surveillance and reconnaissance missions.

Models of IAI's TECSAR and OPSAT satellites were present along with models of IAI's mini-UAS including the Panther and Bird-Eye. IAI's Heron family of UAS, as well as the M-19 HD multi-sensor payload, the HAROP loitering munitions system is being displayed.

"IAI offers a line of systems and sub-systems characterised by breakthrough technologies", stated Joseph Weiss, IAI's president and CEO. "As a global leader in cutting-edge systems such as mission aircraft, UAS, air defence systems, space technologies and cyber security, we combine multiple disciplines and expertise in many technological areas into total solutions. IAI is acting to expand collaboration with both government-owned and private companies in India. This mode of work is contributing significantly to the strong relationship between both sides."

Joseph Weiss, IAI's president and CEO

Alpha agreement with Elbit

The CEOs of Elbit Systems Electro-optics (Elop) and Alpha Design Technolgies exchanged agreements in the presence of Indian Defence Minister Manohar Parrikar on 19 February 2015, for an export order worth $80 million involving manufacture and production of Thermal Imager Fire Control Systems (TIFCS).

TIFCS provides day and night automatic firing capabilities on static and moving enemy tanks and other targets. These high technology systems are not presently in service with the Indian Army and are anticipated to provide a significant improvement in capability once inducted. TIFCS are being manufactured at Alpha's Bangalore manufacturing and test facilities, in technical collaboration with Elop. An export version of TIFCS will be manufactured by Alpha Design Technologies and exported to Elop in Israel over the next 3 years.

Elbit and Alpha executives exchanging agreements in the presence of Defence Minister Manohar Parrikar

Kalyani Group JV with Rafael Advanced Defence Systems

Kalyani Group and Rafael Advanced Defence Systems Ltd. have announced the formation of a Joint Venture Company in India (51:49). The initiative is in line with the 'Make in India' policy of the Government, and will enable the development and production of high end technology systems within the country. This will include a wide range of technologies and systems, like Missile Technology, Remote Weapon Systems and Advanced Armour Solutions. Speaking on the occasion, Baba Kalyani, Chairman & MD, said, "Kalyani Group has been at the forefront in initialising the 'Make in India' campaign. As part of this campaign we aim to develop and produce high end technology systems and expand the Defence Industry Base in our country. We believe in the vision of 'Make in India' and our proposed Joint Venture with Rafael is a step in this direction."

As Brig. Gen (Retd), Itzhak Gat, Chairman of Rafael said, "Rafael has been an active participant in the Indian defence market for the past few years. We have always endeavoured to contribute to the modernisation of the Indian Armed Forces. In the Kalyani Group we see a lot of synergy and opportunities for growth in new markets and especially in India which is strategic market for us. "

Rafael ready for 'Make in India'

Israel's defence technology group Rafael, well known for development of the Iron Dome Counter Rocket and Missile and Trophy active protection systems, was back at Aero India with new surprises: this time, its about C-DOME, a compact yet highly capable naval air defence system, superior versions of the Litening targeting pods and Reccelite reconnaissance systems, as well as advanced communications, command and control that have recently selected for the Indian Air Force future information system.

Through 2014 Rafael Advanced Defense Systems completed a major structural reorganisation that established three divisions: Land and Naval Systems Division, Air and C4ISR Systems Division and Air Dominance Division. "The new formation reflects Rafael's new business focus to best respond to opportunities and needs of its customers and partners." Yedidia 'Didi' Yaari, President and CEO of Rafael told *Vayu*, "I expect these changes to continue our growth in the traditional areas of operation as well as in the new cyber domain."

"India remains a strategic partner for our operation and a major target for our marketing activities, we are offering here many of our top capabilities." Yaari stated, "The Indian move from buying military hardware abroad (Buy) to producing such systems in country (Make) is an important development for Rafael, as it enables us to exploit one of our major advantages as a developer – our ability to cooperate, transfer know how and support local production." Yaari explained.

"Inherent in Rafael's corporate culture, these attributes have helped us to establish over 100 successful partnerships in Israel and with foreign governments and defense companies around the globe. These partnerships leverage Rafael's unique technological edge and proven systems, into defense solutions used successfully around the world," Yaari added.

"One of our strengths in becoming an attractive partner, is our ability to meet technology transfer, local production and offset requirements" continued Yaari. "Although we have yet to finalised the Spike contract, this important win for Rafael is a testament of our ability to meet those requirements and we are excited and honoured by the Indian decision to equip its military with our missiles." These missiles are currently produced in a number of countries and, according to Yaari, Rafael is currently establishing the infrastructure for industrial cooperation that will enable technology transfer to locally produce the Spike missiles in India. "We consider the Indian industry as a true partner in this field, as in areas related to other Rafael activities in India and are confident that this partnership will be introduce an important added value, particularly to the customer and end user," Yaari added.

Elbit : "Smart solutions addressing operational challenges"

Israel's leading defence company, Elbit Systems is witnessing the rebound in demand for advanced systems from defence and homeland security throughout Asia, particularly in India, a trend that would benefit the company in the long term.

"In the short term, the company has to overcome quite a few obstacles, among them, is penetrating the Indian unmanned systems market." While the company's Hermes 900 has won eight sales worldwide since its introduction in 2009, it hasn't been successful selling UAVs to India.

Elbit Systems' CEO - Bezhalel 'Butzi' Machlis

"India has an increasing demand for unmanned systems," Bezhalel 'Butzi' Machlis, President and CEO of Elbit Systems told *Vayu*. "We expect this market to open for more competition and are positioning here the Hermes 900 and Hermes 450, as well as mini and small UAS of the Skylark family. The versatility of those systems is highly suitable for a wide range of applications, carrying EO, SAR, maritime surveillance, electronic intelligence payloads and more." Machlis noted, "Our unique position is in providing a full solution, integrating the platform, sensors and ground-based functions into a robust, highly integrated solution."

Another growth area for Elbit in India is in training and simulation. "We identified pilot and aircrew training as one of the growth areas for the company." Through the years Elbit Systems has developed a wide range of training systems, including range-less air-combat instrumentation (ACMI), virtual avionics, and flight and mission simulators for aircrew of manned aircraft and helicopters, as well as operators of unmanned systems"said Machlis. "The company also established and is maintaining comprehensive training centers for the Israeli Air Force, and is currently offering similar facilities in India, under HALBIT - a joint venture company established with HAL."

At Aero India 2015, Elbit Systems highlighted the SkyBreaker, a networked multi-cockpit, Mission Training Centre (MTC) that supports different aircraft types, by presenting aircrews with high-fidelity, simulator-based training. providing realistic, simulated battlefield training using all aircraft systems and mission scenarios to enhance all levels of pilot training.Other solutions offered by Elbit Systems include Embedded Virtual Avionics, providing on-board system functionality simulation on trainer aircraft and EHUD ACMI system, as part of its offer for the Indian Air Force, Navy and Army Aviation.

Responding to the customers' call of 'doing more with less', Elbit Systems is growing activity in the outsourcing of non-critical services. As defence forces are 'privatising' logistical, training and support activities to industry partners providing such services in a more affordable, Elbit Systems has developed efficient ways to introduce its services this area. "We have recently won major contracts with the Israel Defense Forces (IDF), for maintenance of F-16 avionics, and electro-optic systems; we provide full service support for the Israeli Air Force flight training fleet, supporting the fleet of training helicopters, T-6B, M346 and Grob 120, aircraft which we actually own, offering flying hours on those trainers to the IAF."Machlis noted. Under a similar programme Elbit Systems also manages and operates the Israeli firefighting squadron, providing a lifesaving emergency response service covering the entire country."

UAC's new President at Aero India

Recently appointed United Aircraft Corporation President and Chairman of the Management Board, Yuri Slyusar, was at Aero India 2015 and held meetings with key decision makers in the Indian government and business community.

UAC President and Chairman of the Management Board, Mr. Yuri Slyusar

Born in 1974, Mr. Slyusar graduated from the Moscow State Lomonosov University (MGU) in 1996 as a lawyer and later in 2003 received his doctoral degree in economics from the Academy of National Economy under the Government of the Russian Federation. He started his aviation career at the Rostvertol helicopter plant in 2003 as a commercial director, from 2005 joining the helicopter programmes directorate in Oboronprom. He was appointed assistant to the Minister of Industry and Trade in 2009. A year later he was appointed as Director of the Aviation Industry Department of the Ministry. In 2012 he became Deputy Minister Industry and Trade.

United Aircraft Corporation is the leading Russian company for aircraft building; and owns Russia's leading aircraft designers and producers such as Sukhoi, RAC-MiG, Ilyushin, Tupolev, Yakovlev, Beriev among others, UAC continuing revenue growth since its creation. For the last four years the revenue growth has amounted to 18% per year on average. In 2014 the revenue reached 285 billion roubles. Deliveries are also growing in both civil and military segments.

"Civil and transport aviation programmes will provide for increased growth in corresponding market segments. 2014 saw a rapid increase in SSJ 100 production and delivery rates. The first Il-76MD-90A large transport aircraft was delivered in 2014. As a result in 2015, revenues from civil and transport aircraft programmes are expected to take more than a 25% share in UAC's total revenues", stated Mr. Slyusar.

Rafael's SPICE Family at Aero India 2015

Shown at Yelahanka was the SPICE (*Smart, Precise Impact and Cost-Effective Guidance Kit*) by Rafael Advanced Defence Systems, a family of stand-off, autonomous, air-to-ground weapon systems, capable of hitting and destroying targets with pinpoint accuracy and at high attack volumes. SPICE is combat-proven and in service with the Israeli Air Force and several international customers. SPICE uses state-of-the art navigation, guidance and homing techniques to achieve the accurate and effective destruction of targets with a CEP of better than 3 metres.

Mission plans, in the air or on the ground, use target data (target coordinates, impact angle and azimuth, imagery and topographical data) to create a mission for each target. The pilot allocates a mission to each weapon before release. SPICE is released outside the threatened area, and performs midcourse navigation autonomously using its INS/GPS. SPICE homes in accurately and autonomously to the exact target location in the predefined impact angle and azimuth. While approaching the target, the SPICE unique scene matching algorithm compares the electro - optical image received in real - time via the weapon seeker with mission reference intelligence data stored in the weapon computer memory.

In the homing phase, the system locates the target using scene-matching technology, and uses the tracker to hit it. As a result of this capability, SPICE can overcome Target Location Error and GPS jamming, and can dramatically reduce collateral damage. As it approaches the target, the SPICE mission profile can be set to a specific attack azimuth and impact angle to suit the selected target profile, such as a steep dive angle for deep penetration. SPICE has day, night and adverse weather capabilities, based on its advanced seeker and scene-matching algorithms. SPICE achieves high serviceability with a low life-cycle cost. SPICE simple operation and dedicated Mission Planning System requires only basic aircrew training.

Irkut's MC-21 Programme update

Russia's Irkut Corporation, well known in India as manufacturers of Sukhoi Su-30MKI fighters, plan to roll out the first MC-21-300 new generation narrowbody airliner by the end of 2015. The maiden flight is scheduled for 2016, while first deliveries to customers are planned for 2018.

The development of this 150-200-seat airliner is currently the primary programme for Russia's civil aviation industry, whose *raison d'être* is to enter the global single-aisle airliner market and "challenge" the Airbus-Boeing duopoly, held by the A320 and 737 families respectively. Russian officials believe that the time is now for a clean-sheet design that can redefine this segment.

In order to provide a competitive platform, Irkut and its partners have applied new technologies and embraced radical new design methods, which have not been used in single-aisle aircraft until now. Chief among these is the extensive use of lightweight composite materials in construction of the airframe. In addition to making significant aerodynamic improvements possible, this also greatly reduces structural weight. The same approach in new generation long-haul aircraft, such as the Boeing 787 and Airbus A350, has proved effective and Irkut hopes to replicate these gains in the production of short-haul aircraft. By comparison, contemporary short-haul single-aisle aircraft are quite conservative in design and construction.

Computer-generated rendition of the MC-21-300 in flight (photo: Irkut)

Russian officials feel that the Indian market is of particular interest for the MC-21 and this possibility was raised in November 2014 when Russia's Deputy Prime Minister Dmitry Rogozin visited New Delhi. Irkut President Oleg Demchenko in fact believes that collaboration with Indian manufacturers on the MC-21 programme may prove as fruitful as the on-going Indo-Russian collaboration for the Sukhoi Su-30MKI fighter programme.

VAYU Interview with Lars-Olof Lindgren, Chairman, Saab India

VAYU : Well before the 'Make in India' call was made, Saab has upheld that 'The Future is Made in India'. It has been reported that the company has been quietly working on plans to build the Gripen in India to meet the requirement for next generation, affordable fighters and considerable planning has been done in this regard. Could you kindly elaborate on that aspect in the current scenario where the private sector is being encouraged?

LOL: India is one of Saab's most important markets, and we are supplying a broad range of defence products here. As per the MMRCA requirement, India decided to go with an alternative other than the Gripen, which of course we respect. But if India should see a need for further purchase of fighter aircraft, we are still committed to offer Gripen. We are convinced that the Gripen is a perfect fighter for the IAF, which fully meets Indian requirements and needs.

The Gripen as a system raises a country's defence capability. One part of this capability is to improve knowledge about the system via technology transfer. As a Swedish company we know the importance of trade and cooperation. Therefore we understand why 'Make in India' is important. If the Indian Government were to engage in discussions with Saab on Gripen, 'Make in India' would of course be a natural part of our offer.

The Next Generation Gripen is under contract with both Sweden and Brazil, so there is a firm development plan with the Gripen NG, the programme is on track. For future customers, adjustments can easily be made to ensure both a configuration of Gripen suited to their needs as well as local participation and technology transfer in production.

The Next Generation Gripen E

VAYU : In recent presentations, Saab's consistent focus has been on 'breaking the thought barrier', with cutting edge future technologies being offered. Can we have a brief on those pertinent for India ?

LOL: Our strong focus on developing systems at the cutting edge of technology is very evident in the systems we have on offer in India. We have offered the RBS 70 NG for the Indian tri-service VSHORAD programme. For the Army SRSAM programme Saab has offered the BAMSE system including Giraffe AMB. Saab is already providing the Integrated Defence Aid Suite (IDAS) for the Advanced Light Helicopter. IDAS is a fully integrated multispectral warning and self-protection system for airborne platforms.

We have also offered the RBS 15 anti-ship missile to the Indian Navy. This can be launched from land, air and sea and can be suitably configured as a land attack cruise missile. In addition to this missile, Saab has also responded to the Navy's RFI for the mobile coastal missile systems with integrated C2 and RBS 15.

VAYU : Saab's electronic defence systems have been offered for the HAL Dhruv advanced light helicopter (ALH). What is the status of this programme ?

LOL: Saab's IDAS system has been selected as the electronic warfare self-protection system for the Indian Army's and Air force's Advanced Light Helicopter (Dhruv). The programme is now in the series production phase and has received multiple production orders. IDAS is a system designed to provide self-protection for airborne platforms in sophisticated, diverse and dense threat environments. IDAS is a fully integrated multi-spectral system that can be configured for radar warning, laser-warning and missile-approach-warning.

VAYU : Saab has recently signed an agreement with Indianeye Security to market Agile Tactical Engagement Simulation (ATES) systems for the Indian forces. How do you expect to benefit from this partnership ?

LOL: ATES is a scalable, agile, and rugged training system for realistic simulation of all 'force on force' tactical scenarios with all weather and all terrain capability. It is the only tactical training simulation system that allows seamless transition of exercise from open terrain into built up area and inside pre planned mapped and instrumented buildings in day/night scenario. ATES is a complete instrumented training system that can be adapted to meet the individual requirement of each specific customer. Its main features are:

Saab's strategy for the Indian market involves partnership and co-operation with Indian companies for all major defence and security programmes it will participate and compete in. The exclusive distribution agreement with Indianeye Security Ltd will facilitate delivery of Saab's Agile Tactical Engagement Simulation (ATES) equipment to Indian Paramilitary, Special Forces and the Police.

RBS 70 being fired

"Boeing anticipates growth of services and support business"

The services and support market is a significant growth area for Boeing which is working with the Indian Air Force and Indian Navy to provide training and support of Boeing platforms such as the P-8I maritime reconnaissance and anti-submarine warfare aircraft and C-17 Globemaster III airlifter and the Head of State aircraft.

Boeing is supporting the IAF's C-17 Globemaster III fleet through the Globemaster III Integrated Sustainment Programme (GISP) contract. This has resulted in unprecedented levels of mission capable rates that enable the IAF to use the aircraft for the missions they want. This was demonstrated in the humanitarian missions for *Cyclone Hudhud* and flood operations in Bihar and Jammu and Kashmir when the C-17s airlifted people and material to safety.

The high mission readiness rates are a result of Boeing's C-17 GISP, "virtual fleet" arrangement ensures mission readiness by providing all C-17 customers access to an extensive support network for worldwide parts availability and economies of scale, making the C-17 more affordable to own and operate. The C-17 GISP is a system-level partnership with the US Air Force, where the customer pays for readiness, rather than specific parts or services.

For ten consecutive years, the C-17 GISP exceeded required readiness rates while reducing the ratio of dollars spent per flight hour. Whether it is a peacekeeping, wartime or humanitarian mission, Boeing provides a full continuum of support products and services dedicated to supporting the warfighter with the highest level of readiness at the lowest cost of ownership.

Boeing supports India's P-8I fleet by providing spares, ground support equipment and field service representative support. Boeing's integrated logistics support enables the highest state of fleet readiness at the lowest possible cost and has demonstrated reduced ownership costs and decreased cost per flight hour over multiple platforms. More than 7,000 Boeing 737s are in active service all over the globe enabling all derivative aircraft, including the P-8A Poseidon, to benefit from this uncommon economy of scale for sustainment and support needs. By leveraging unique 'One Boeing' capabilities, Boeing Global Services and Support (GS&S) is deploying a sustainment solution for P-8I that draws on synergies from Boeing's Commercial Airplane Services, including its subsidiary, Aviall, while leveraging the economy of scale unique to commercial derivative aircraft, specifically the 737, the world's most prolific commercial aircraft, in service and in production.

Initial qualification training of Indian Air Force C-17 crews was conducted by the US Air Force at Joint Base Charleston in South Carolina. A total of 100 Indian Air Force airmen received instruction from the 373rd Training Squadron Detachment 5 on how to operate India's C-17 Globemaster IIIs. The training included classroom time as well as simulator training.

Initial P-8I training for Indian Navy pilots, mission system operators and maintenance technicians that will operate and maintain P-8I aircraft were carried out in Seattle. The programme included a combination of flight, classroom and lab training as well as real-world simulation experiences that can reduce total ownership costs. Between February and September of 2013, Boeing trained more than 110 Indian Navy professionals, including five pilot crews, five mission crews and a number of flight signalers and observers.

Boeing anticipates other training opportunities for aircrew and maintenance courseware development for platforms such as the AH-64 Apache and CH-47 Chinook, opportunities which being pursued. Boeing has been providing simulation based training solutions to the US Army and several other international customers operating the AH-64 Apache and CH-47 Chinook helicopters.

Courtesy: Boeing

"Defence Offsets .... a Catalyst"

Defence Minister Manohar Parrikar at Aero India 2015

After the flurry of Aero India's inaugural and walk around the exhibition area, Defence Minister Manohar Parrikar faced an impatient media at his Conference before lunch on 18 February. Flanking him on the dais were the RRM, Rao Inderjit Singh, Secretary Defence RK Mathur, Secretary Defence Production Mohan Kumar and, for sometime, the CAS Air Chief Marshal Arup Raha, the latter leaving midway for other commitments.

The media had a golden chance to get the Minister's formal views on a whole gamut of vital issues on defence and aviation but this was derailed by some hysterical journalists wanting him to address a completely non-related (to Aero India) matter : that on the Coast Guard's role in the destruction of an alien fishing trawler off the Coast of Gujarat some weeks earlier. the matter was 'sub judice', it was not right to make more comments. But by when ? insisted many seekers of an answer, but the reply remained tantalisingly vague .... "end February, early March" after which "it would be shared" (as this issue goes to press in early April, nothing has emerged).

.... ships, submarines, fighters yet to be paid for and that necessity for acquisition does not mean that the equipment has to be immediately purchased".

The query as to why there were no Russian aircraft at Aero India 2015, the Minister quipped that 'of course' they were

India's indigenous design and development potential is captured in this splendid image of HAL's light combat helicopter (LCH) waiting for take off even as an ADA Tejas light combat aircraft (LCA) touches down after its flying display

Still some pertinent questions were raised and answered. Status of the Rafale programme was repeatedly queried, with the programme still 'hanging' three years after this fighters selection as the MMRCA of choice. The Minister stated that a detailed report has been asked for from the contract negotiating committee (CNC) and since

In context of the MMRCA acquisition being included in the Defence Budget for 2015-16 ("premature to comment before presentation in Parliament on 28 February") Mr Parrikar analogised that when visiting a supermarket, "one feels like buying everything but then is sobered by one's budget .... there are earlier commitments

.... "only they are flown by Indian pilots!." In the same context on the observation that there was "more US presence this time" the Minister said that there was greater participation at the Show generally.

Considering that "one thousand helicopters are required for the armed forces, there were so few displayed at Aero

India the Minister said that HAL had several new helicopter types at the Show but the country needs to ramp up the rate of manufacture to perhaps "50 to 100" per year. This could be also by expanding the eco system to also involve the private sector, and specific mention was made of the "388 reconnaissance and surveillance helicopters" required by the armed forces.

The Minister was candid regarding the Defence Procurement Procedure (DPP), the 2013 edition of which "is not exactly a document which clarifies many of the aspects and issues", and remains very confusing. A new DPP is on its way and will be issued "in a couple of months" ! However, the new approach of 'Make in India' will be outside its purview.

Later, speaking at the Interactive Session on Defence Offsets organised by Confederation of Indian Industry, Mr Manohar Parrikar stated that Defence Offsets are a Catalyst to kick-start Defence Manufacturing but there was need to effectively implement existing policies and procedures and to compress the producrement time frames.

Baba N Kalyani, Chairman CII National Committee on Defence and Chairman, Bharat Forge echoed the view that Defence Offsets are the means to kick start defence manufacturing in any given country in the present context. In India,

Flagship of HAL's Helicopter Complex is the Dhruv advanced light helicopter (ALH) a demonstration example of which is seen in this image. (photo: Angad Singh)

defence offsets are one of the lowest in the world at 30 percent of the contract value. Offset banking "is a good idea …. and can be utilised to engage with the foreign OEMs well in advance".

In his address, Phil Shaw, Co-Chairman CII Defence International Cooperation Sub-committee and Chief Executive, Lockheed Martin India said that his company has obligations amounting to US $ 40 billion worth of defence offset globally. "Defence offsets should be a win-win situation for both sides and not a zero sum game".

The US presence at Aero India 2015 is epitomised by this image of a Boeing C-17 Globemaster III taking off with a pair of Lockheed-Martin F-16Cs on the apron

Chief Speak

Air Chief Marshal Arup Raha, Chief of the Indian Air Force, held an "interactive session" with the media on 19 February at Aero India 2015. After a short speech he swiftly moved towards the question-answer part, which was most eagerly awaited. The Vayu editorial team was present 'in strength' as this was perhaps the most significant interaction of the Show, considering the vital issues faced by the Vayu Sena.

Drawdown in combat squadrons

Indicative of the great national concern about increasing obsolescence in the IAF's combat aircraft fleet, when asked about the urgency in replacement of MiG-21s in the IAF, the Chief candidly stated that the IAF is aware of the drawdown of IAF combat squadrons, especially MiG-21s and MiG-27s. While the IAF is in the process of upgrading some MiG-21s, many others are legacy and obsolescent which need to be replaced. "In the long term, it is a perspective plan of the armed forces. So we have a drawdown, we have to make up for that drawdown. We eventually need 42 combat squadrons for the Indian Air Force, and the process has already started. We require a replacement aircraft and the Rafale has been selected as 'L1', the negotiations are on. It is important that we have the MMRCA. I will not say the Rafale or whatever it is, but we need to have the MMRCA in the quickest possible time because the drawdown is there,"he emphasised.

Dassault Rafale B carrying out aerobatics over Yelahanka (photo: Angad Singh)

So, where is the MMRCA?

The all important matter of the MMRCA was repeatedly discussed, with media querying the lack of an alternative plan. "I think the Raksha Mantri made it very clear that CNC is at an advanced stage and there are four sub-committees. All the committees have completed their task in terms of negotiations with the L1 vendor. The fourth sub-committee is the contracting committee, to finalise details of the contract. So there are some issues which are being resolved. The Raksha Mantri had mentioned that he is trying to give an impetus to

IAI

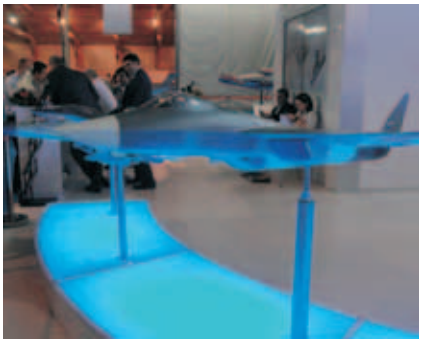
complete this part of the sub-committee's work. I will leave it at that. No, we have no plan B as of now; we're not working on any plan B, only working on the plan A," responded Air Chief Marshal Raha.

Building up the Tejas LCA

Responding to a question on formation of the first Tejas LCA squadron, the Air Chief said that HAL was trying to build production capacity to eight aircraft a year. While the first two Tejas series production aircraft (SP-1 and SP-2) were aircraft where "changes were constantly made", the third such aircraft (SP-3)will be the aircraft whose production standard would be frozen, and all subsequent aircraft will be to that (IOC) standard. 20 LCAs are planned for the first production tranche, and from the third aircraft onwards, they will be to the same standard."We will only be able to operationalise the (first) LCA squadron when we reach four aircraft of the SP-3 standard. We need a minimum of four such aircraft. Hopefully by this year end, we should be able to do this. We will have the full complement of aircraft, that is 20, by 2016-early 2017," said the Air Chief. He reiterated the IAF's faith in the LCA adding that "As far as weaponisation is concerned, in the LCA Mk.I, we have proven its capability at the firepower demonstration of 2013. There is no doubt about its capability in an operational role."

Tejas LCA displaying at Aero India 2015 (photo: Angad Singh)

Jumping ahead : FGFA and AMCA



Models of the FGFA and AMCA displayed at Aero India 2015

Futuristic programmes including the Fifth Generation Fighter Aircraft (FGFA) and Advanced Medium Combat Aircraft (AMCA) were also reviewed, with the CAS stating that "in terms of building up 42 squadrons in the future, FGFA is important capability-wise. This aircraft was expected to have started production by 2018-19, but there have been delays. We are trying to compress the timelines. If everything works out, I think we should have a sufficient number of FGFAs." The Air Chief also stated that AMCA is also "in the pipeline, both the preliminary design and the subsequent development."

Back to Jaguar upgrades

Asked about re-engining of the Jaguar, he responded "You see the Jaguar has got enough life left. We have done our process study and this is a very capable aircraft. It had some shortfalls in terms of engine power. It is a very good aircraft in terms of delivery. We are trying to upgrade it in terms of having an autopilot, then some close combat missiles, better navigation systems and weaponssystems and of course a new engine for the thrust required for the modifications we are doing. The Jaguar is a very good aircraft and we are working with BAE for its product support and life cycle which I think will last till about 2034. This has been planned well and if it all works out and HAL carries out the modifications at the right time, we will have continued capability till 2034."

On the subject of UCAVs in futuristic air combat, the Chief commented "Any capable air force would like to have UCAVs and, yes, the IAF has plans, we are working with the DRDO on this matter and I am sure the programme will fructify."

Asked about the 'Avro replacement' and the single vendor situation impacting this programme, the Chief responded by saying that a "further study has been ordered" and once the results are in, the MoD will take its decision "speedily."

DARIN II Jaguar (note RWR and reprofiled nose) seen on approach for landing (photo: Angad Singh)

"Champion of the Champion"

Chairman HAL meets the media at Aero India 2015

Just a few weeks after taking over as Chairman of Hindustan Aeronautics, T Suvarna Raju conducted his first press interaction, impressing media veterans and newcomers alike with his confidence and forthright manner. "2015 is going to be a very special year for HAL," he stated, referencing the company's 75th year of existence, and pointed out that the firm had already been "a champion of the champion of the *Make in India* concept for decades".

On the production front, he noted that HAL has made considerable progress in the manufacture and overhaul of Su-30MKIs and is currently building these from the 'raw material' stage. With some 160 aircraft delivered as of March 2015, the Chairman asserted that the experience and expertise gained through the programme meant that HAL could very nearly be considered an OEM for the type! Commenting on the recently realised indigenous Su-30MKI overhaul capability (*see Vayu I/2015*), he said HAL could support the IAF's Su-30MKI fleet for the next 30 years and also explore export opportunities among the various countries around the globe that operate similar Su-30 variants.

HAL has built and delivered some 160 Su-30MKIs to the IAF since the programme began

He also announced that HAL had completed modifications on a Su-30MKI for carriage of the air-launched variant of the Indo-Russian Brahmos cruise missile. In fact, the modified aircraft was handed over in a small ceremony shortly after Suvarna Raju's press conference (*see item in this Issue*).

On the LCA front, the Chairman stated that HAL is geared up for production of the type, having built a new 28,000 m^2 facility with jigs and tooling "already calibrated to micron-level tolerances." He went on to announce that funds amounting to Rs 1,300 crore had been earmarked to double the production rate to sixteen aircraft per year from the present eight. Plans for further production rate increases would be dependent on additional orders from the IAF beyond the 40 fighters already contracted for, he clarified. Suvarna Raju was keen to point out that the LCA programme had a large level of private sector MSME (Micro, Small and Medium Enterprise) involvement, with production of some 8,000 components outsourced to these firms.

He also briefly touched upon HAL's long time collaboration with ISRO, and the new Integrated Cryogenic Engine Manufacturing (ICEM) facility coming up in Bangalore. The ICEM will produce the all-important cryogenic and semi-cryogenic engines for ISRO's GSLV Mk.II and Mk.III launch vehicles.

Production of the Tejas LCA is being given priority by HAL

Helicopter development remains a strong bias with HAL, the Dhruv and Rudra deliveries continuing and LCH development showing encouraging progress. The Chairman said that HAL had sanctioned a fourth LCH prototype, to be built using internal funds, to expedite IOC of the type. The third LCH prototype (TD-3) first flew in November 2014 and was on static display at the show, even as the second prototype (TD-2) was in Leh for high altitude and cold weather trials, illustrating how far the development programme has come (*see item in this Issue)*.

The single-engine Light Utility Helicopter (LUH), according to Suvarna Raju, "is an important programme for HAL" with an anticipated order of 400 to 600 helicopters. Rs 400 crore has been

HAL Rudra (ALH Mk.IV) seen with external weapon pods

earmarked for the design and development of the LUH which has already had its first ground run in December 2014. First flight is expected later this year (August ?), followed by certification in 2017. A greenfield 610-acre Helicopter Complex is being set up in Tumkur, close to Bangalore for production of LUH as well as the eventual Naval Multi-Role Helicopter (NMRH), which specific type is yet to be selected by the Indian Navy. Highlighting the firm's confidence in the helicopter market, Suvarna Raju said that the facility is planned to have a sizable production rate of 60 helicopters per year.

Speaking on HAL's internal R&D efforts, the Chairman said that HAL was moving toward realising its ambition of becoming a 'technology' firm, with various internal programmes underway, supported by company funding. In the 2013-2014 period, for example, HAL had spent Rs 1083 crore on R&D and has been filing ever-increasing numbers of patents. A 25 kN jet engine and a 1200 kW turbine

HAL Light Combat Helicopter (LCH) technology demonstrator - 3

Mock up of HAL's Light Utility Helicopter (LUH) on display outside Hall 'E' at Aero India

engine are under development for fixed and rotary wing applications respectively, he said. In addition, HAL is also working with ADE for development of a range of indigenous UAVs.

While DARIN III upgrades for IAF Jaguars and the Mirage upgrade programme are already providing stimulus to the pool of expertise at HAL, Suvarna Raju said that the firm has also been "proactive in proposing upgrade solutions" for licence-built aircraft such as Hawk, Su-30MKI and Dornier 228, in order to obviate concerns on long-term sustainability of these types in service. He also clarified that the re-engining programme for the Jaguar fleet was

File photo of IAF Jaguar coming into land at Ambala. HAL are currently upgrading this strike fighter to DARIN III standards

viable with a Honeywell engine (the F125 afterburning turbofan), which statement was also echoed by the Air Chief in his press conference (*see article in this Issue*).

Suvarna Raju then addressed a number of issues facing HAL. On the MMRCA, he said that as the nominated production agency, HAL was in communication with Dassault regarding contractual matters. While Rs 400 crore has been allocated to establish the basic production facility infrastructure for the programme, he said HAL could only wait for the MoD to sign off on the contract to make further progress. Regarding the much-discussed issue of the contract's liability clause, the Chairman was resolute that, but for deliveries of contracted parts or sub-assemblies, HAL does not depend on an outside OEM for quality assurance of products manufactured by them. Robust internal processes at HAL, coupled with inspections by the regulatory agency "would be more than enough", he reiterated.

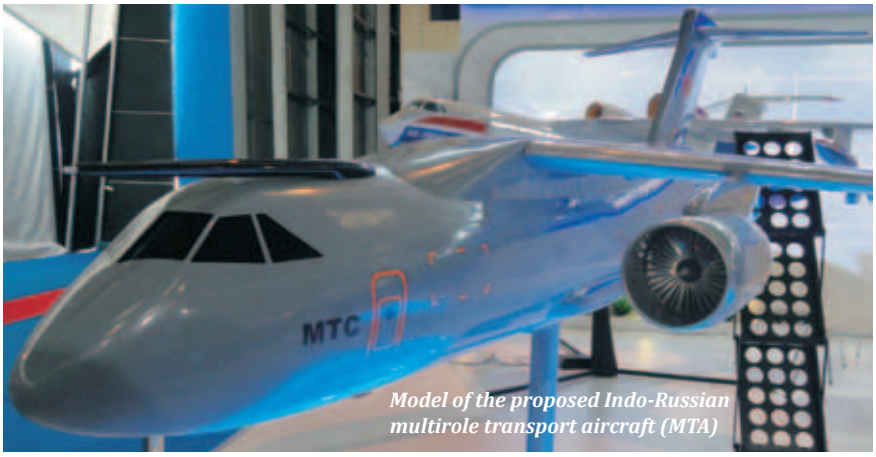
Responding to concerns about the slow progress of the Indo-Russian Medium Transport Aircraft (MTA) programme, the Chairman was frank in his acknowledgment of the delays and attributed them to the non-availability of an aero engine that could meet the IAF's demanding requirements, as well as sharply escalated development costs on the Russian side.

Equally straightforward when pressed on HAL's progress with the indigenous HTT-40 basic trainer aircraft, Suvarna Raju said that this much talked about aircraft would make its first flight in mid-2015! The Garret TPE-331 engine that HAL already has a licence to produce for the Dornier 228s built in Kanpur has been selected to power this indigenous turboprop trainer, making the Chairman's optimistic prediction for the type's first flight seem less fanciful.

Photos by Angad Singh

File photo of IAF Mirage 2000H on take off at Gwalior

HAL has been building Hawk Mk.132 Advanced Jet Trainers under licence from BAE Systems



Model of the proposed Indo-Russian multirole transport aircraft (MTA)

"Focus on the AMCA"

Dr K Tamilmani, DG Aerospace DRDO interacting with the media at Aero India 2015

During his media interaction at Aero India 2015, Dr K Tamilmani, DG (Aero), spoke candidly on the successes and failures of DRDO, the near- and medium-term goals of the organisation and then went into some detail on the projected timeline for the advanced medium combat aircraft (AMCA) programme.

Briefly touching upon on status of some key ongoing programmes, before concentrating on the next generation AMCA, he said that the Astra BVRAAM is "progressing well," with further trials of the system to be carried out on a Su-30MKI by the Aircraft Systems and Testing Establishment (ASTE) in March. Dr Tamilmani briefly spoke about the enigmatic K-4 Submarine Launched Ballistic Missile (SLBM) project, whose 3,000 km range will give India true 'second-strike' nuclear deterrent capability. Work on the missile is underway, with another test launch from a submerged pontoon planned "fairly soon".

The Tejas LCA had pride of place at the DRDO exhibition in Hall 'D'

Tails telling tales : Tejas SP-1 and CABS AEW&C at static display

And what of the LCA programme ? He stated that the second series production aircraft (SP-2) would be delivered "soon" (*see 'Chief Speak' article in this issue*) and that the LCA Navy project was "progressing smoothly". More ski-jump trials are to be conducted in March, he said, and the first arrested landings planned for September-October 2015.

Dr Tamilmani also referred to projects that were planned to enter service "soon" (within 1-2 years), including a 16-tonne heavy drop parachute system, the Panchi UAV (wheeled variant of the Nishant UAV), and the longer endurance Rustom-I tactical UAV. Continuing on the UAV front, he stated that DRDO were working alongside HAL and the Indian Navy on a rotary-wing UAV to operate from warships at sea. In the interest of saving time and funding, he said, DRDO were exploring relationships with foreign manufacturers having expertise in the rotary-wing UAV field.

Dr Tamilmani said that "the basics are in place" for the indigenous Airborne Warning and Control System (AWACS-India), referring to the development of an airborne radar for the programme. However, the project is unable to proceed without selection of a suitable aircraft for the type. DRDO is considering a twin-engine widebody (A330 or B-767 class) for this requirement and proposals from global OEMs "will be considered shortly".

Speaking about aerospace development projects in general, Dr Tamilmani acknowledged that creation of test facilities in-country is priority and mentioned that wind tunnels and flying test beds are particular areas of importance. While wind

LCA Navy NP-2 at Yelahanka

Artist's depiction of LCA Navy on launch from aircraft carrier ski ramp

Panchi UAV displayed outside DRDO Hall 'D'

tunnels could be obtained via offsets, citing Boeing as a potential collaborator on a supersonic wind tunnel, he said that while the HAL-built Dornier 228 test bed recently delivered to DRDO would be "invaluable" for radar and avionics testing, development of aero-engines would require a larger, dedicated aircraft. With multiple engine development projects underway in the country, Dr Tamilmani was sanguine that instead of 're-inventing the wheel,' focus should be on implementing substitutes for technology which are unavailable commercially and not for engines that can be bought 'off the shelf.'

Hereafter, focussing on the AMCA; he announced that preliminary design had already been "frozen" and claimed that DRDO already has the 'basic technologies' needed to execute the programme, but that these needed to be suitably adapted for the demanded performance.

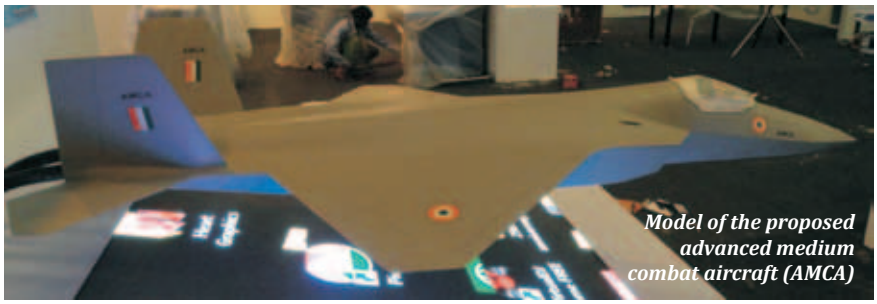
He highlighted three key technology areas required for the AMCA, which are not available on the LCA : stealth, thrust vectoring engines and supercruise, but stated that all three areas are "already under active development by DRDO". With two of these three key capabilities (thrust vectoring and supercruise) critical upon the aero-engine of choice, and as India is still away from this technology, Dr Tamilmani accepted that the AMCA's engine would have to be imported.

HAL-Dornier 228 flying test bed with DRDO, displayed at Yelahanka which AFS also houses a score more 228s which serve as multi-engine conversion trainers with the IAF

"By late-2019, we will need an engine to be integrated with the AMCA. We are discussing options with multiple engine vendors: Rolls-Royce, GE, Snecma, amongst others. We could buy an upgraded version of an existing engine, with its output enhanced to 110 kN," he said, for the first time revealing that there is a firm target for engine performance in the project. Whether the 110 kN figure is a static thrust measurement or the target thrust level to be obtained *after* installation (typically resulting in small performance losses through the inlet and thrust vector nozzle) however was not clarified.

Most contemporary military turbofans, including the GE F414 which India is planning to use on the Tejas Mk.II, produce between 90 and 95 kN of thrust, which explains Dr Tamilmani's remark that any foreign vendor selected to power the AMCA would need to offer a significantly uprated engine.

Rather unusually, he even suggested a possible vendor, saying, "With the government-to-government route with the US now open, we would be happy to use the GE F414 engine. We have been working with the smaller GE F404 on the Tejas for a long time and have seen no problems." Also unusual was the mention of Russia as a collaborator for the thrust vectoring portion of the engine, which would take the programme into a curious hybrid situation of combining Russian and Western technology on a single engine!



Model of the proposed advanced medium combat aircraft (AMCA)

Also, again most unusually, Dr Tamilmani laid out detailed time lines for the AMCA at a time when development agencies are reluctant to comment on exact dates from fear of being vilified for delays. A firm budgetary requirement would be arrived at "next year", he said, and this is currently being formulated with great care, as "we cannot keep going back for funding again and again." Clearly, some lessons have been learned from the LCA programme.

He said that the first AMCA would be mated with a selected engine by late-2019, with first flight planned for early 2020. "I will need four years from that date for flight testing with four prototypes. In 2024, I should be able to freeze the AMCA design, and then we can start production," he concluded.

(Left to right) : Dr VK Aatre (former SA to RM), T Suvarna Raju (Chairman HAL), Dr K Tamilmani (DG, Aero) and Mr SK Sharma (Chairman, BEL) at the Aero India International Seminar

War and Peace :

from anti-ISIS ops to showy Bangalore !

At Aero India 2015, *Vayu* learned that aircraft from both the foreign fighter demonstration teams, the US Pacific Air Forces F-16 Demo Team and the French Rafale Solo Display team, had conducted anti-ISIS combat operations very shortly before arriving at Yelahanka for the air show. The two twin-seat Rafale Bs from the French detachment were from *Base Aérienne* 104 at Al Dhafra in the UAE, and bore the markings of *Escadron de Chasse* 3/30 'Lorraine.' The single-seat Rafale C on static display wore *Base Aérienne* 118 (Mont-de-Marsan, France) and EC 2/30 'Normandie-Niemen' squadron markings. The French Air Force Colonel commanding the display detachment was keen to point out that the single-seater had conducted its last anti-ISIS air strikes on 9 February, before heading to Yelahanka a mere two days later on 11 February!

The French are using twin-seat Mirage 2000Ds and all three variants of the Rafale (twin-seat B, single-seat C, and carrier-based single-seat M) for anti-ISIS operations in the Middle East, and French Air Force officers at Yelahanka indicated that the Rafale was by far and away the most capable aircraft at their disposal in-theatre. They highlighted the Rafale's payload advantage over the Mirage 2000 while both types carry a Thales targeting pod on dedicated fuselage pylons, they noted that the typical loadout for a Rafale strike sortie is six 500-lb bombs (either GBU or AASM), 4 MBDA MICA missiles and three drop-tanks, providing it with substantial striking power, self-defence capability and endurance. In contrast, the Mirage 2000D is only able to carry two 500-lb bombs, two MICAs, and two drop-tanks in order to maintain a balance between strike, self-defence and range.

The two American F-16Cs were both from 13th Fighter Squadron 'Panthers' based at Misawa Air Base in Japan. The 35th Fighter Wing at Misawa consists of two F-16 squadrons (13 FS and 14 FS), and is primarily a Suppression/Destruction of Enemy Air Defence (SEAD/DEAD) unit. Sporting the signature 'WW' tail code ('Wild Weasel' is the USAF nickname for SEAD aircraft) of the 35 FW and red tail stripes indicating their squadron (14 FS aircraft have a yellow stripe instead), one of the aircraft also bore mission marking painted discreetly inside the nose-wheel door, with five bombs and a bullet depicted in red paint. Upon being asked, a USAF Captain with the team confirmed that these were anti-ISIS mission markings, and that despite nominally being a SEAD/DEAD unit, 35 FW trains for all roles that can be carried out using the F-16, which include a range of air-to-air and air-to-ground missions. The five bombs represent five separate air-to-ground strikes and the bullet represents a strafing run for close air support (CAS).

Angad Singh

Mission markings visible on the nose wheel door of this USAF F-16C as Captain Austin Brown taxis out for a display flight at Aero India (photo: Angad Singh)

An Al Dhafra-based Rafale B heads back to the apron after a practice flight (photo: Angad Singh)

‘Mister LCA’

Vayu meets Group Captain Suneet Krishna with his Tejas LCA

Group Captain (retd) Suneet Krishna has been flying the HAL Tejas Light Combat Aircraft for over a decade, and is arguably the most experienced pilot on the type. So it is far from unusual that he has virtually always been selected to conduct Tejas flying displays at the biennial Aero India show held at Yelahanka AFS.

After serving for over twenty years in the Indian Air Force, as a fighter pilot and then becoming test pilot, Gp Capt Krishna joined ADA in April 2001, only a few months after the LCA prototype’s maiden flight in January that year. His test-flying career has seen him fly just about every type of fixed-wing aircraft operated in India, from the diminutive piston-engine HPT-32 basic trainer, through a variety of fighters and up to multi-engine transport aircraft including

Inspecting Tejas LSP-3 (KH2013) before flight...

... signing off after ensuring the aircraft is satisfactory ...

the Dornier 228, BAe (Avro) 748 and An-32. Overall, Gp Capt Krishna has flown more than 5,000 hours on more than 40 different aircraft types!

He has also served as Officer Commanding, Flight Test Squadron at the IAF's Aircraft and Systems Testing Establishment (ASTE), and was Chief Test Pilot at HAL's Transport Aircraft Division.

At ADA, he catapulted into the limelight for his role in the Tejas flight test programme, and his dedication to test flying was immediately apparent. He played a key role in a number of important areas, such as the LCA's flight envelope expansion, flight control system (fly-by-wire) development, high angle-of-attack (AoA) testing, air-to-air and air-to-ground weapon integration, and avionics testing. Of course, all this was punctuated by air show display flights not only at the controls of the Tejas, but also the NAL Saras light transport, Dornier 228 and NAL Hansa-3 light trainer.

Suneet's commitment was often rewarded, a few notable honours include being selected to carry out first flights for Tejas PV-1 (Prototype Vehicle 1, tail number KH2003) and LSP-4 (Limited Series Production 4, tail number KH2014). The Aeronautical Society of India's *Dr VM Ghatage Award* bestowed on him was most appropriate.

Vayu had a brief opportunity to catch up with Gp Capt Krishna as he headed out for a Tejas display practice flight a few days before Aero India 2015 formally began, and were able to document his pre-flight preparations before he carried out another sterling demonstration, for which he has become so well known.

(text and photos: Angad Singh)

... climbing into the cockpit ...

... and in flight some minutes on.

First women officers
join IAF's Sarang helicopter display team

The Indian Air Force's 'Sarang' helicopter display team has inducted its first female pilot, Squadron Leader Deepika Misra, and a woman engineering officer, Flight Lieutenant Sandeep Singh.

Flt Lt Sandeep Singh

It was as a Flight Cadet at her passing out parade at the Air Force Academy in December 2006, that Deepika Misra "fell in love with the aerobatic displays by the IAF's *Surya Kiran* and *Sarang* display teams. She imagined herself flying some day in either of the two teams but back then it seemed an impossible dream. She did not give up hope and was commissioned in the helicopter stream with her first posting to a Chetak/Cheetah helicopter unit. At the time, these single-engine light helicopters were the only rotorcraft female short-service commissioned pilots were permitted to fly.

In a major policy shift in 2010, the IAF allowed conversion of women pilots to twin-engine medium and heavy-lift helicopters. Having clocked nearly 1,600 hours on Chetak and Cheetah helicopters at Bareilly and Udhampur, Sqn Ldr Misra was more than ready when the opportunity came. The IAF meanwhile also sought volunteers for women helicopter pilots to join the Sarang Team. Sqn Ldr Misra promptly took on the new challenge, and was among the first women pilots to begin conversion onto the Dhruv ALH.

Sqn Ldr Misra joined the Sarang unit in July 2014 but while she was the first woman to do so, she was not alone for long. Flt Lt Sandeep Singh, a lady engineering officer soon joined Misra in the *Sarang* unit. Both Deepika and Sandeep now share the rare distinction of being the first lady officers in the Sarang team in their respective disciplines.

Sqn Ldr Misra is nearing completion of her operational conversion before commencing actual display flying as a Sarang formation member, training hard to understand the nuances of formation flying, for the present, she is happy in her role as 'Safety Officer' of the team. In this role she is required to monitor the team's displays and debrief team members after their sorties. "It is a great learning process," she says.

Meanwhile, a crucial responsibility rests on the shoulders of Flt Lt Sandeep Singh. Keeping the Dhruvs serviceable at all times is her charge, along with six other engineering officers. Having another lady officer in the team as a flying member is "a great source of inspiration," she says.

Sqn Ldr Deepika Misra in the ALH cockpit

Both Deepika and Sandeep are, however, sure of one thing: they have a responsibility to uphold the highest standards expected of them and they are hopeful that someday there will be an all-woman cockpit in one of the Dhruvs in the *Sarang* quartet !

(with inputs from IAF PRO)

AERO INDIA 2015

The Yakovlev Team executes a loop during an air display

Of Skywalkers and Pussycats

To the 'teeming millions', this is what they came for and possibly got their money's worth. However, to the professional exhibitors, both Indian and international, the jostling crowds that were admitted into the Air Force Station Yelahanka on the trade days themselves, meant that seriousness had been eclipsed by what had quickly deteriorated into an exercise in frivolity or a *'tamasha'*. Aero India 2015 had been billed as 'Asia's Premier Air Show' with the theme of 'Make in India' in Aerospace, Defence, Civil Aviation, Airport Infrastructure and Defence Engineering and a long roster of international exhibitors,

The Swedish 'Skycats' wing-walking team displaying with their Grumman Ag-Cat biplane

Breitling Wingwalkers perform heart-stopping aerial gymnastics atop a pair of Stearman biplanes

some 500-odd companies paid serious money for taking part at this 10th edition of Aero India. However, the 'authorities', perhaps in missing formation aerobatic teams such as the *Surya Kirans* of yore, were happy to promote the antics of flying circus teams from Europe to make up for this and so deem the Show as "a great success."

On the last two days of Aero India 2015, an estimated half a million men, women and children thronged the exhibition site, ogling at the European birds (of various kinds), clicking pictures and generally having a picnic. The masses went home satisfied, but how cost-effective the show was for its exhibitors still remains to be assessed.

Line-up of aerobatic types at the show, with Yak-50s in the foreground and 'Viking' biplane in the background

Swedish aerobatic pilot Jacob Holländer performs for the teeming crowds on one of the public days

'Skycats' wingwalkers from the Scandinavian Airshow team wow the public at Yelahanka

The Aero India 2015 International Seminar

Aerospace : Vision 2050

As has become routine, an International Seminar in downtown Bangalore precedes the Aero India Air Show and Exhibition at AFS Yelahanka, some 20 kilometres north of the megalopolis and so it was in February 2015. The lofty theme at this year's event was 'Aerospace: Vision 2050', organised by the Defence R&D Organisation in association with the Aeronautical Society of India. As per past practice, the traditional host is the Secretary Defence R&D and the Defence Minister is Chief Guest but in 2015, there was no Secretary nor Defence Minister to adorn the stage at NIMHANS Convention Centre in this year's edition. Nor indeed present was the Chief of Air Staff, all this being somewhat disconcerting to the many hundreds assembled including scores of invitees and speakers from overseas.

Still, 'the Show must go on' and thus on 16 February, it was Dr K Tamilmani, Director General (Aerospace) of the DRDO who welcomed Rao Inderjit Singh, Minister of State for Defence who graced the occasion and took centre stage along with Chairman HAL T Suvarna Raju, Chairman BEL SK Sharma, the Minister of State for Heavy industries & Public Enterprises GM Siddeshwara and Dr S Christopher, Programme Director AEW&C, who was Chairman of the Seminar Organising Committee.

In his presidential address, Rao Inderjit Singh recounted several recent achievements of India's aerospace industry, from ISRO's successful Mars Exploration Spacecraft programme including the 'Mars Orbiter Mission' to DRDO's successful test-firing of Agni series of Intermediate Range Ballistic Missile (IRBM). Lauding the recent successful launch of Agni-V just two weeks earlier, which has a range of over 5,000 km and capable of carrying a warhead of over one tonne, the Minister said : "The Agni-V is a major addition to the country's strategic strike capability".

In contrast, achievements in the aviation field were somewhat subdued, with fleeting references to "other notable DRDO achievements including 'Nirbhay', the indigenously developed sub-sonic long-range cruise missile, Airborne Early Warning & Control (AEW&C) system and Light Combat Aircraft (LCA) among others. In his message published in the *Seminar Souvenir*, Defence Minister Manohar Parrikar had referred to "the recent success in the field of LCA, Missiles, Unmanned Aerial Vehicles, Mars Orbiter Mission and

Advanced Light Helicopters which have forced the world to recognise the capabilities of the Indian Scientists".

Special theme of the Seminar was, unsurprisingly, the 'Make in India' economic programme launched by the Prime Minister which "opens up opportunities for innovative minds to exploit the globally evolving spirit of 'teaming up' and 'pooling resources'". Earlier the MoS for Heavy Industries & Public Enterprises, GM Siddeshwara described the various indigenously developed systems in aerospace as "symbols of 'Indian prowess' in the aerospace arena".

A major departure from earlier such Seminars was the Panel Discussion on 'Window of Opportunities' with the Minister of State for Defence Rao Inderjit Singh taking centre place on stage for a lively two hours of animated discussion, professionally moderated by the inimitable Maroof Raza Gilani. Alongside the Minister were Air Marshal PP Reddy, Chairman CISC, Dr VK Aatre, former Scientific Advisor to Defence Minister, Vice Admiral Raman Puri, former Chairman CISC, Baba Kalyani, CMD Bharat Forge, Dr Peter Gutsmiedl, from Airbus Defence & Space and Dr Krishnadas Nair, former Chairman HAL and President SIATI. (Preceding the discussion was presentation of Dr Nair's book 'Make in India' published by *The Society for Aerospace Studies*, to Rao Inderjit Singh).

Many issues were flagged not the least punctuated by an attentive audience who candidly commented upon existing 'sacred cows' including the LTIPP, DPP, CDS and so on. Hinted upon was the Government's intent to review the Defence Procurement Procedure ("after the budget session of Parliament"), the possible appointment of a Chief of Defence Staff (whatever be the nomenclature) and that the long term integrated perspective plan which "ought to encompass 25 years." There were numerous points raised including identification and nomination of private sector partners in the defence industry, emulation of the 'navy model' in procurement of capital equipment while on the LCA, the Minister side-stepped critical references on programme delays, stating that (if) "the air force are accepting it … we cannot have a contrary view".

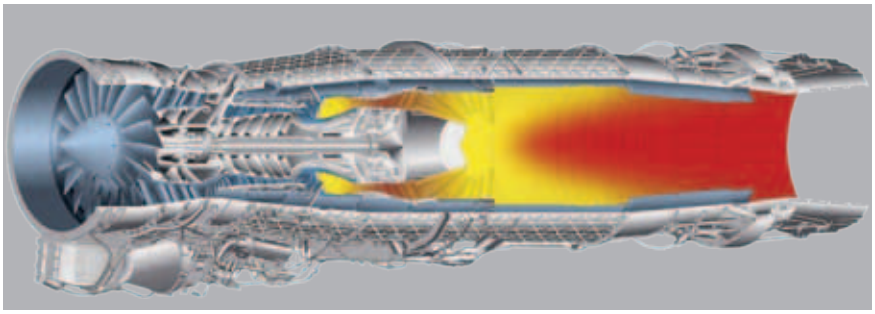
For rest of the day and the next, there were near four score Technical Sessions in various Halls of the NIMHANS Convention Centre with a surfeit of excellent subjects, eagerly attended by those professionally involved in the aerospace industry as also observers and analysts. While Air Vice Marshal Rajeev Hora, Commadant ASTE spoke on changing perspectives in flight testing, M Brandfass of Airbus Defence and Space from Friedrichshafen, Germany talked on Multifunctional RF-Systems Objectives. Mr Paul Stein of Rolls Royce focused on Systems Engineering for Evolving Scenarios while the combination of Wolfgang Sterr and Thomas Braun from Eurojet, Munich gave the audience much food for thought in their presentation on the EJ200 engine, its optimised design, manufacturing, integration and product support technologies.

Amongst eagerly awaited – and attended – lectures were those by Cmde JA Maolankar, Chief Test Pilot at NFTC, who spoke on the Design and Testing of an aircraft carrier borne fighter aircraft, with the LCA (Navy) as central theme (in his session, there was 'standing room only').

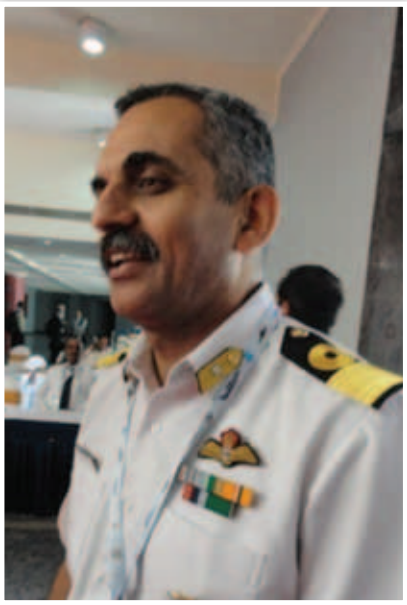
Jitendra Singh, former programme manager of NCAD (NAL) looked at feasibility studies of fighter aircraft characterisation methodology and then came the indefatigable Prashantsingh Bhadoria, heading the design & development of HAL's HTT-40 basic trainer programme, with his focused presentation in Hall A. 'His' project is taking tangible shape, with the prototype's fuselage assembles and wings having been manufactured and powerplant near integration (*Vayu* understands that the selected engine is Honeywell's TPE 331-12B of 1250 shp).

Another well attended session was that by Group Captain Vikram Singh Chauhan, Additional General Manager (Design) at HAL's Transport Aircraft Division, Kanpur who spoke on 'continued airworthiness of transport class of aircraft' with focus on the Dornier 228 light transport aircraft which HAL has been manufacturing since the mid-1980s.

Minister of State for Defence Rao Inderjit Singh with Pushpindar Singh (The Society for Aerospace Studies) and Dr CG Krishnadas Nair at release of the book 'Make in India'.



Wolfgang Sterr and Thomas Braun of Eurojet ..... and the EJ 200 for powering new generation fighters



Cmde JA Maolankar of the NFTC ... and launch of the LCA (Navy) from the shore based skiramp at INAS Hansa, Goa

Prashantsingh Bhadoria ... and the HTT-40 (note shadow of a fighter)

Gp Capt Vikram Singh Chauhan ... and HAL Dornier 228 flying test bed of the DRDO

In fact, since the erstwhile Dornier GmbH went through various takeovers, first by Daimler Benz and then Fairchild of the USA in the late 1980s, this eventually resulted in closure of the German manufacturing activity and HAL has remained the sole production agency for this versatile light transport aircraft, having produced near 150 Dornier 228s, almost entirely for the Indian Air Force, Navy and Coast Guard with some aircraft exported to 'friendly' neighbourhood countries.

With the short lived association with RUAG of Switzerland behind it, HAL is now rapidly advancing to upgrade its Dornier 228, including a new generation glass cockpit, upgraded power plants and development of an amphibian version.

'The Best Ever LIMA' !

The 13th Langkawi International Maritime & Aerospace Exhibition was held from 17 to 21 March 2015, at what is perhaps the most spectacular settings for such events worldwide. This Show took place even as Malaysia will assume chairmanship of the Association of Southeast Asian Nations (ASEAN) this year.

LIMA, under the stewardship of Dato Seri Hishammuddin Tun Hussein, Minister of Defence, has put in motion a strategy "to rival the best aerospace and maritime exhibitions in the world." Key to this strategy were two overarching ideas: creating a marketplace for the commercial aerospace and maritime industries, similar to what is currently implemented at LIMA for defence, focusing on the ASEAN market and injecting business activities to foster networking of ASEAN and global businesses, in-line with the ASEAN integration agenda.

Russian Helicopters at LIMA

Russian Helicopters showcased its latest developments at LIMA 2015 and included its Mi-171A2 and Ansat helicopters. Military models were show cased in their stands and included the Mi-35M, Mi-171Sh, and Mi-17V-5 helicopters for representatives of the law enforcement agencies in Malaysia and other countries of South East Asia. Today, Russian-made helicopters are operated in over 100 countries in the world, including many in the Asia Pacific region. In total, about 1,500 medium and light Russian-made helicopters are operated in the region.


Mi-171A2

"Countries in the Asia-Pacific region are experiencing dynamic economic development. Demand for helicopters in the region is constantly growing. Our company is interested in this region and is eager to expand its presence here," said Russian Helicopters CEO Alexander Mikheev." At LIMA 2015, we are showcasing the latest Russian-made commercial helicopters that are most relevant, in particular to countries across South East Asia. We are seeing interest in these models among our potential partners, and hope to develop mutually beneficial cooperation."

LIMA'15 hosted over 500 companies from 35 countries, with an 11% increase in company participation compared to its previous edition. 70% of the world's top 25 aerospace and defence companies along with the world's top 5 helicopter manufacturers were present at LIMA'15 including 'giants' such as Boeing, Airbus, DCNS, Kongsberg, Lockheed Martin, Bell Helicopter, AgustaWestland, Thales, Rafale, BAE Systems, Saab, MBDA, DSME and Sikorsky. 16 country pavilions featured at LIMA'15 including international and regional countries such as the United States, United Kingdom, South Korea, Australia, China and Japan. LIMA'15 was one of the first exhibitions to host Japanese defence companies following the relaxation of Japan's defence exports in April 2014. ASEAN country pavilions also featured for the first time at LIMA'15.

Alongside the exhibition, LIMA'15 also saw record numbers of aircraft and ships with an estimated 100 aircraft on display at the Mahsuri International Exhibition Centre (MIEC) and over 50 warships at Porto Malai. The LIMA'15 aerobatic show featured show stealers UAE's Al Fursan, along with returning crowd favourites, the *Russian Knights,* Malaysia's *Krisakti* and TNI-AU's *Jupiter* aerobatic teams.

LIMA'15 hosted 38,500 trade visitors and with new initiatives such as the Commercial Delegation Programme, which includes delegations from International Civil Aviation Organisation (ICAO) and GIFAS, the French Aerospace Industries Association, was specifically designed to bring more visitors to Langkawi.

As Malaysia is coming to the end of the 10th Malaysian Plan (2011-2015), which outlines government spending, no major procurement is expected to be undertaken for this year. However, companies are already positioning themselves for the beginning the next plan when new procurement priorities will be announced. All three services of the Malaysian Armed Forces, plus Malaysian Armed Forces Headquarters (for overall MAF and tri-service requirements), have to submit their funding requests to the government for the 11th Plan and the programmes that will be funded under it by mid-June this year.

Whether all these programmes will be approved is open-to-question, given Malaysia's financial constraints. Prime Minister Najib Tun Razak's administration

Official handover of first Airbus A400M to RMAF

The Royal Malaysian Air Force (RMAF), on 17 March, officially received its first of four Airbus A400M military transport aircraft, ordered from Airbus Defense and Space.

Thumbs up for RMAF's 1st A400M from the Prime Minister of Malaysia

Chief of RMAF, General Dato' Sri Roslan Saad officially took over the aircraft from Bernhard Gerwert, CEO of Airbus Defence and Space. The ceremony took place at the Langkawi International Maritime & Aerospace (LIMA) 2015 in the presence of the Prime Minister of Malaysia Dato' Seri Najib Razak and Minister of Defence Dato' Seri Hishammuddin Hussein. Malaysia is the first export customer of the A400M outside of the original launch nations.

The occasion also marked the debut of the A400M at LIMA 2015. The technologically-advanced airlifter had earlier performed a special fly-past at the Show's opening ceremony. "As a new generation multi-role transport aircraft, the A400M will strengthen RMAF's tactical and strategic capabilities. It will enable us to undertake an extraordinary range of military and humanitarian operations within the country and regionally," said Chief of RMAF, General Dato' Sri Roslan Saad.

As Bernhard Gerwert, CEO Airbus Defence and Space, said: "We are extremely proud to deliver the first A400M to our first export customer and we want to congratulate Malaysia on its foresight and vision. The A400M is the ideal aircraft for a region like Asia-Pacific and we are sure that Malaysia will show the way here on how beneficial the A400M can be."

has preferred a rolling approach to the Malaysia plan rather than setting the complete five year allocations at the outset; recent five year plan allocations have been decided on a year-to-year basis during the plan's timeframe based on Malaysia's fiscal capability to support projects. As a result some of the armed forces request for the 11th Plan may be not be approved at the outset but instead placed on hold for later consideration.

Among the Royal Malaysian Air Force's (RMAF's) requests under the 11th Plan is the Multi-Role Combat Aircraft (MRCA) replacement for its MiG-29s. Although the project has been ongoing since 2011 little has been done because of the costs and it is unlikely any purchase will be signed in the near term despite the RMAF's fighter fleet depletion. The air force has deactivated its F-5 fleet of six aircraft and still plans on retiring the MiG-29 by December this year. There is the possibility of a life extension programme for the MiGs as a stop-gap measure.

In addition, recent events, including the traumatic loss of MH370, have led to a reprioritisation away from the MRCA to the need to maintain adequate airspace domain awareness. At the top of the list are additional ground based radars systems and beyond that is the procurement of an airborne early warning and command (AEW&C) aircraft with secondary maritime surveillance capabilities.

Both Northrop Grumman with the E-2D Hawkeye and Saab with the Erieye are pushing their capabilities. Saab has an MOU signed in 2011 with local company Deftech on an AEW&C collaboration and in January this year signed an MOU on industrial cooperation on the Gripen. However, given the cost of an AEW aircraft, it would seem unlikely that funding for such a programme would become available in the near future.

Two programmes are likely to go ahead. These are for the upgrade of the RMAF's C-130 and S-61 helicopter fleets. Malaysia's Airod was awarded MOUs for both programmes during DSA 2014. The LOI for the C-130 upgrade covers the upgrade of the RMAF's entire fleet of 14 C-130s' avionics and communications to meet international aviation standards and the installation of glass cockpits to the aircraft, while the LOI for the S-61 upgrade covers upgrades to the entire fleet of 26 helicopters. The Malaysian Army is set to request six attack helicopters under the 11th Plan which was revealed by deputy defence minister Abdul Rahim Bakri in Parliament on 18 December 2014. Abdul Rahim also stated that the attack helicopters were required for the conduct of security operations in the Eastern Sabah Security Zone, which was established in response to the incursion by Sulu militants in 2013.

The attack helicopter operational requirement for East Malaysia could also be postponed given Malaysia's arming of several of the RMAF S-61s and Army Air Corps AW109s with Hybrid M134D-H Gatling guns plus the transfer of four Royal Brunei Air Force S-70A Blackhawks to Malaysia. The RMAF currently operates two S-70As in the VIP transport role but the four ex-RBAF Blackhawks are to be used in East Malaysia for security operations there and it is likely that Malaysia will seek to arm these helicopters as well.

On the naval side, since the 2013 incursion by Sulu militants, the Royal Malaysian Navy (RMN) has had to focus on both blue water and brown water operations simultaneously. However, the need to procure small craft for operations in maintaining security for Eastern Sabah to prevent a repeat of the 2013 budget has not impacted the navy's blue-water procurement plans as funding for operations in the Eastern Sabah

DCNS at LIMA

DCNS's local and long-term commitment in Malaysia is exemplified by the creation of its subsidiary, DCNS Malaysia. Furthermore, DCNS is in a close partnership with Boustead Group in Malaysia through the Joint Venture Boustead DCNS Naval Corporation (BDNC) for In-Service Support of the Royal Malaysian Navy submarines. "Indeed, DCNS offers this complete set of solutions in cooperation with Navies and local suppliers. Furthermore, DCNS provides a wide range of support services during the entire lifecycle of surface ships and submarines in order to support Navies in maintaining and expanding their self-sufficiency." The DCNS exhibit at LIMA featured the Gowind 2500 and the Gowind 1000 with SETIS, the Scorpene 2000 and Scorpene 1000 submarines, the OPV 75, the MU 90 and Canto, and an innovative concept ship, the SMX-OCEAN. The Scorpene 2000 submarines, already chosen by the Royal Malaysian Navy, represent state-of-the-art in submarine design and construction and benefit from the latest technologies developed for nuclear-powered classes operated by the French Navy, particularly as regards acoustic discretion and combat system performance.

RMN Scorpenes

Security Zone comes out of a special allocation rather than the navy's allocation under the defence budget.

As in other areas, financial considerations are affecting the RMN's plans. This includes cancelling two Batch 2 *Lekiu* class frigates in 2009 though the RMN was compensated by the subsequent go-ahead for the six Littoral Combat Ships being built by Boustead Heavy Industry Corporation (BHIC) with technical assistance by France's DCNS.

At the same time, the procurement of a multi-role support ship still remains outstanding despite the loss of the LST KD *Sri Inderpura* in 2009 to a ship fire, which took away much of the RMN's amphibious operational capability. Even plans to buy second hands ships have been scuttled due to lack of funds; prior to their acquisition by Indonesia, the RMN had been keen to purchase the three *Nakhoda Ragam* class OPVs but were unable to persuade the government to release funds for them.

Given the situation it remains to be seen whether the RMN's request under the 11th Malaysia Plan of 2016-2020 will be fulfilled. The RMN has requested funding for some 36 programmes estimated to cost a total of RM10.181 billion. A full list of the programmes requested has not been publicly revealed but the Chief of the RMN, Adm Abdul Aziz Jaafar stated in his New Year address to the RMN on 7 January that among the programmes were the procurement of eight missile corvettes and six anti-submarine helicopters; the service life extension and upgrade of the four *Laksamana*-class corvettes; the procurement of small craft and the replacement of obsolete missile and torpedo systems on existing RMN ships.

In addition it is likely that the RMN would also seek upgrades to its two *Lekiu* class frigates, that entered service in 1999 particularly the combat systems and the Sea Wolf missile system, given the UK plans to phase out the Sea Wolf in 2018, though the RMN could extend the service of the Sea Wolf if it draws on the RN's phased out stocks. The *Laksamana*-class SLEP is likely to be approved given that it will be done locally, most likely with BHIC, which completed the SLEP for the *Kasturi*-class corvettes.

On the eight missile corvettes, it would be difficult to see funding being approved given the costs, particularly with the ships specifications of being 75-100m in length and armed with anti-ship, anti-air and anti-submarine warfare capabilities though there is the possibility that the Malaysian government may approve a lesser number to be built.

Additionally, the RMN is planning eight corvettes to replace its four *Handalan* and four *Perdana* Fast Attack Craft (Missile), all of which entered service in the 1970s. Korea's DSME appears to be positioning itself for this requirement, having signed a contract on 24 November with Malaysia's NMEL to provide six corvettes to the RMN subject to Malaysia initiating a purchase.

VSC (Vayu) and additional inputs from Dzirhan Mahadzir

AgustaWestland delivers two more AW139s to Malaysia

AgustaWestland has recently delivered two new AW139 intermediate twin engine helicopters to Malaysian operators recently to perform corporate and VIP transportation. These latest deliveries mark continued success of the AW139 in Malaysian and corporate transport markets. Nearly 30 AW139s have been sold in Malaysia with aircraft in service with corporate customers, Weststar Aviation Services, Bomba and the Maritime Enforcement Agency. Customers in Malaysia benefit from a wide range of AW139 training courses for technicians and aircrew available at the AgustaWestland Malaysia Training Academy, including pilot training on an AW139 Level D Full Flight Simulator. AgustaWestland Malaysia also provides a wide range of support services for the AW139 from its Subang facility near Kuala Lumpur.

The AW139 can accommodate up to 15 passengers or six to ten passengers in a number of spacious and comfortable VIP seating arrangements. The six large cabin windows provide passengers with an excellent view from the cabin with access via sliding doors or a hinged door. A wide range of customer specified optional equipment is available on the AW139 including audio visual equipment, telecommunications and refreshments stowage. The baggage compartment provides 3.4 m3 (120 ft3) of easily accessible storage with access from external doors and also the cabin if required.

A Unique Offering

Alenia Aermacchi at LIMA 2015

MC-27J with door plug (photo: Lidie Berendsen)

Finmeccanica-Alenia Aermacchi is uniquely offering its customers a latest generation fighter (Eurofighter Typhoon) and a tactical transport aircraft with an established worldwide reputation (C-27J Spartan). The company is an Italian-based aeronautics concern and among the world's top players in the design, development, manufacture and support of commercial and military aircraft, trainers, unmanned aerial systems and aerostructures.

Alenia Aermacchi can certainly claim to include amongst its wares, combat proven medium tactical airlifter, the C-27J; participation in the Eurofighter programme and the manner to ensure the smooth transition of pilots from basic trainers to the complexity system of the new generation combat aircraft with an advanced Integrated Training system encompassing capabilities, syllabus, safety and maintenance.

To this range of products the company has also added a wide network of joint ventures with an extensive range of civil portfolio, from the ATR to Sukhoi Superjet 100 and important partnerships with Boeing and Airbus.

Finmeccanica-Alenia Aermacchi has a consolidated presence in Malaysia and in the South East Asia (SEA). The MB-339AM and the more recent MB-339CM jet trainers, have been in service with the *Tentera Udara Diraja Malaysia* since 1983 and 2009 respectively. In some SEA countries military pilots gain their wings with the Alenia Aermacchi SF-260 primary trainer and several millions fly in ATR regional aircraft with the country's airlines fleets.

Malaysian and other Asian Air Forces currently have an ongoing defence modernisation programme through investments in terms of technology, weapon systems and training. In the Alenia Aermacchi range of products there are types perfectly suited for the demanding operational requirements typical of scenarios in SEA: a complete Integrated Training Systems (ITS) to enhance training effectiveness and efficiency, reducing cost and preparing crews to manage complex systems of systems and no longer just fast fighters as in the past.

The Typhoon

The M-345

A new-generation medium tactical airlifter - including the C-27J Spartan twin-engine tactical transport and the MC-27J Special Mission Aircraft- is available for multi-mission roles.

There are also interesting opportunities for the Sukhoi Superjet 100 (SSJ100), which is optimised for medium range regional routes. In this area the SSJ100 was sold to Sky Aviation and Laos airlines. In India, the manufacturer has signed a Letter of Intent with Bishwo Airways. Maritime patrol versions of the ATR can carry out all maritime patrol roles with extremely low operational costs: search and identification of surface ships, SAR (Search & Rescue) missions, anti-narcotic, piracy, and smuggling operations, monitoring and environmental protection and economic exclusion zone (EEZ) patrol.

With over 50 years of unrivalled experience in pilot training, Alenia Aermacchi has developed an unique Integrated Training System (ITS) which is now in production for several customers including an aircraft, full mission simulators, mission support system, academic training media and training management tools.

With its range of trainer aircraft, the company can cover the complete pilot's training syllabus, from the primary to the basic phase on the low-cost and single-engine turbofan-powered new M-345 HET, up to the advanced and LIFT (Lead-In Fighter Training) phase on the twin-engine M-346.

About the M-346, it is easy to say that recent successes of the aircraft are the best demonstrations of its capability. Ordered by Italy, Poland, Singapore and "a Middle East" country, for a total of 59 aircraft, the M-346 provides reduced acquisition and operational costs. Furthermore the reduced number of hours necessary for its maintenance make the aircraft excellent for cost-effectiveness.

The new entry in the Alenia Aermacchi trainer range is the M-345 HET (High Efficiency Trainer), the most recent solution proposed by Finmeccanica-Alenia Aermacchi for the basic-advanced training phase. The M-345 HET is superior than a turboprop trainer: it has lower acquisition costs and the same operating costs, but offers pilots true jet experience, speed and performances. With the M-345 HET Alenia Aermacchi proposes a solution which gives a cost-effective ratio lower than the modern 'heavy' turboprop trainers. Compared to these aircraft, the M-345 features decidedly higher performance, specifically with regard to transfer speed to the training range and the altitude, leading to a drastic reduction of 'idle times' in each training session, because within the representative flight hour the student pilot can perform a higher number of tasks included in Training Needs Analysis thus completing the syllabus in a 25% shorter time period (from the standard 120 hours down to 90).

The C-27J Spartan is considered as the benchmark in the new-generation, medium battlefield airlifter category. The C-27J has been ordered by the Air Forces of Italy, Greece, Bulgaria, Lithuania, Romania, Morocco, the US, Mexico, Australia, an "undisclosed African customer", Peru and the Slovak Republic. In total, 80 C-27s have been ordered.

The Spartan has already fully demonstrated its capability to effectively accomplish any tactical transport mission. It provides high performance, extreme operating flexibility and cost efficiency and it is the only aircraft in its class capable of interoperability with heavier airlifters.

The MC-27J is a new, multi-mission version of C-27J, a battlefield tested platform, adaptable, agile, and affordable, able to execute a wide range of customer-driven missions. For the MC-27J, Alenia Aermacchi has adopted a modular approach maximising the use of mission-pallet kits (Roll-On/Roll-Off equipment), for both systems and armament. The MC-27J is not just a gunship, but a battlefield platform equipped with proven-sensors/ communications/weapons suite able to execute a wide range of customer-driven missions.

(Courtesy : Finmeccanica)

Sukhoi Superjet 100

Egypt orders the Rafale

Responding to Egypt's selection of the Rafale omni-role fighter, Eric Trappier, President & CEO of Dassault Aviation stated "Dassault Aviation is greatly honoured by the Arab Republic of Egypt's decision to equip its air force with the Rafale. This decision is a continuation of our cooperation that dates back to the 1970s, and has seen the Mirage 5, the Alpha Jet and the Mirage 2000 fly in

the colours of Egypt. The Rafale meets the needs of countries that, like Egypt, demand a sovereign air force of the best level. I would like to thank the highest Egyptian authorities for this strategic and historic partnership. Dassault Aviation will be equal to the faith that they have placed in us yet again. I would also like to thank the French authorities, which were behind the Rafale programme, and have provided the political support, without which we cannot make any military exports. I would also like to pay tribute to the skills and know-how of the 7,000 people who work on the Rafale at Dassault Aviation, Thales, Safran and for our 500 subcontractors."

The Rafale omnirole fighter first went into active service with the French Navy and the French Air Force in 2004-2006, gradually replacing seven types of aircraft belonging to the preceding generations. It was deployed in Afghanistan (2007-2012), Libya (2011), in the Sahel-Saharan strip (since 2013) and in Iraq (since September 2014). Rafale was selected for the Indian Air Forces' MMRCA requirement for 126 aircraft.

F-35 towards full weapons certification

All three variants of the F-35 Lightning II continue towards full weapons certification, successfully completing numerous milestones during the previous four months. Highlights include validating 2B weapons software and successfully executing several weapons separation and engagement tests. The most recent accomplishments are in support of the first military service Initial Operational Capability (IOC) declaration by the US Marine Corps in July 2014.

The programme also surpassed 25,000 combined flight hours in December 2014 with F-35 military fleet aircraft (16,200 hours) nearly doubling the System Development and Demonstration

An F-35A at Edwards AFB seen with its Systems Development and Demonstration Weapons Suite the aircraft is designed to carry.

(SDD) test aircraft (8,950) hours. Comprehensive flight test on the F-35A variant GAU-22 25mm gun system is scheduled to begin mid-year at Edwards AFB, Calif., and will include ground fire tests, muzzle calibration, flight test integration and in-flight operational tests. The 25mm missionised gun pod carried externally, centerline mounted on the F-35B and F-35C, also begins testing this year to meet US service's desired schedule for full warfighting capability software known as 3F. The 3F software is currently planned for delivery with the Low Rate Initial Production Nine (LRIP 9) US aircraft in 2017.

USN approves Raytheon SM-6

The US Navy has authorised ships in the Aegis Combat Weapon System baselines 5.3 and 3.A.0 series to deploy the Raytheon Standard Missile-6. The authorisation expands the missile's use from five ships to more than 35 ships. "SM-6 is the longest range integrated air and missile defence interceptor deployed, and its multi-role capabilities are unprecedented," said Mike Campisi, Standard Missile-6 senior programme director. "Its use is transforming how we define fleet defence."

Raytheon has delivered more than 130 missiles to the US Navy, which deployed SM-6 for the first time in December 2013. SM-6 is a surface-to-air supersonic missile capable of successfully engaging manned and unmanned aerial vehicles and fixed- and rotary-wing aircraft. It also defends against land-attack and anti-ship cruise missiles in flight. Final assembly takes place at Raytheon's state-of-the-art SM-6 and SM-3 all-up-round production facility at Redstone Arsenal in Huntsville, Alabama.

Airbus DS naval radars for US Navy

Airbus Defence and Space Inc. has installed the third TRS-3D naval radar for the US Navy's Littoral Combat Ship (LCS) programme through its agreement with LCS prime contractor, Lockheed Martin. The radar has been integrated on the third *Freedom* variant of the new Littoral Combat Ships, *Milwaukee* (LCS 5). In total, eight TRS-3D radars, designated AN/SPS-75 by the US Navy, have passed their equipment acceptance tests, each now in varying stages of installation within the USS Freedom variant ships.

The TRS-3D is a three-dimensional, multimode naval radar for surveillance, self-defence, gunfire support, and helicopter control. It is used to automatically locate and track all types of air and sea targets. Among the ships equipped with TRS-3D are the National Security Cutters of the US Coast Guard, and outside the US, the K130 corvettes of the German Navy, the 'Squadron 2000' patrol boats of the Finnish Navy and the Norwegian Coast Guard *Nordkapp* and *Svalbard* icebreakers.

PAF inducts JF-17 into CCS

The Pakistan Air Force has introduced the locally-manufactured JF-17 Thunder to its Combat Commanders' School (CCS), which will use the type for advanced combat training. The PAF CCS is broadly analogous to the IAF's Tactics and Combat Development Establishment (TACDE), and presently operates a mix of Chengdu F-7s, Lockheed F-16s and Dassault Mirage IIIs.

The JF-17 was formally inducted at a ceremony at PAF Base Mushaf in Sargodha on 26 January 2015, when five JF-17s were delivered to CCS at the base. The PAF currently has two operational JF-17 squadrons (Nos. 16 and 26).

Boeing Maritime Surveillance Aircraft

The Boeing Maritime Surveillance Aircraft (MSA) programme is to begin customer demonstration flights, having completed baseline ground and flight testing of the aircraft mission systems. Flights for prospective operators are scheduled to begin in coming months, the mission system testing following last year's airworthiness and certification testing. The testing included hundreds of scenarios to confirm performance of the Automatic Identification System, radar, Electro-Optical Infrared camera, communications radios and data links, Communications Intelligence System and the Electronic Support Measures.

MSA is a multi-intelligence maritime surveillance platform that leverages investments in the P-8A Poseidon and the Airborne Warning and Control System Block 40/45 aircraft mission systems to provide a high capability, low-risk intelligence, surveillance and reconnaissance solution in a mid-size business jet. The aircraft's potential missions include anti-piracy, immigration patrols, Economic Exclusion Zone enforcement, coastal and border security and long-range search and rescue.

New Captor-E radar for Eurofighter

The Eurofighter will be equipped with a new generation radar to enhance the aircraft's capabilities and substantially improve the pilots' ability to survive. During a meeting of the defence state secretaries of the Eurofighter nations (Great Britain, Germany, Italy and Spain) held in Edinburgh, representatives of Eurofighter

Jagdflugzeug GmbH and NETMA (NATO Eurofighter and Tornado Management Agency) signed a €1 billion contract to develop a new, electronically scanned radar, the 'Captor-E'.

Airbus Defence and Space is playing a major role in development and integration of the radar, via its Military Aircraft and Electronics business lines. "Together with our partners in the Euroradar consortium, we are developing the world's most powerful fighter radar," said Thomas Müller, head of the Electronics business line at Airbus Defence and Space. "This order will ensure ongoing development of radar technology, which is a core military capability in Germany."

The new radar is being developed by Eurofighter Jagdflugzeug GmbH and the Euroradar consortium comprising Selex ES (Great Britain, Italy), Indra (Spain) and Airbus Defence and Space (Germany). The consortium has already developed and produced more than 400 Captor radars.

Diehl demonstrates IRIS-T SL

Following system validation one year ago, Diehl Defence's IRIS-T Surface Launched (IRIS-T SL) demonstrated its full performance as the most advanced Short to Medium Range Surface-to-Air Missile (SAM) extant. During this final firing campaign, concluding guided missile qualification at the Overberg Test Range in South Africa in January 2015, three guided firings were executed in different short- to medium-range and very low- to high-altitude scenarios. All of them resulted in direct hits of the target drones: to prove the capabilities of IRIS-T SL, jet target drones of different sizes were used performing a large variety of realistic evasive maneuveres.

German Air Force A400M Full Flight Simulator

The German Air Force has taken delivery of a Full Flight Simulator for the A400M aircraft provided by Airbus Defence and Space. The training device entered service at Wunstorf Air Base, where the GAF A400M fleet will be based, and will be used to train about 60 German crews in its first three years in operation. Developed by Airbus Defence and Space and manufactured by Thales, this is a full replica of the A400M cockpit.

Ian Burrett, HO Training & Aircrew Operations, Military Aircraft, said: "The delivery of this FFS is an important step in creating the GAF´s own A400M training programme and as part of the overall support infrastructure that will sustain the A400M in service for many years to come". The GAF took delivery of its first A400M on 18th December 2014.

Finmeccanica gets contracts "in every business sector"

The end of 2014 was characterised by new contracts for the Finmeccanica Group when four important agreements in "every sector" of the Group's activities were signed. In the Aeronautics sector, Finmeccanica-Alenia Aermacchi signed a €120 million contract with ARMAEREO (Italian National Armaments Directorate) to provide the Italian Air Force with further three advanced trainer M-346s, with ground base training system and relevant logistic support included.

In the Helicopters sector, Finmeccanica-AgustaWestland will provide 160 civil AW189 helicopters to the oil company Rosneft. The supply will be provided mainly through HeliVert, a joint venture between the Italian company and Russian Helicopters (a subsidiary of the corporation Rostec). HeliVert will be responsible for the final assembly (in its Tomlino plant near Moscow) of the helicopters that will be provided by AgustaWestland. The agreement includes the supply of integrated services (maintenance and training) for customers in Russia and CIS countries. With this supply of 160 civil helicopters, Rosneft will become the first customer for AW189 worldwide.

In Defence Electronics and Security, Finmeccanica-Selex ES, as the lead of an industrial grouping, has announced the award of a European bid for tenders called by ENAV, the Italian air traffic control service provider, to design and set up the new generation air traffic control system in Italy (4-Flight programme) that will replace in nine years the existing one. The contract is worth about €206 million.

Saab and Boeing on T-X programme

Saab President and CEO Håkan Buskhe has said that cooperation with the Boeing company on the US Air Force's future T-X trainer programme is going "tremendously well". Saab has a team at St Louis, and Boeing in Linköping, working together with additional investments being made in the development of lead-in fighter trainers for the USAF. Buskhe stated that "we have set up criteria that we think we need to achieve to have a great chance of winning. Breaking the cost curve, increased performance – that's something we're working on".

Competition is reportedly from General Dynamics/Alenia Aermacchi partnership offering a T-100 development of the latter's M-346; Lockheed Martin, which is promoting Korea Aerospace Industries' T-50; and Northrop Grumman, which has announced its intention to offer a new platform which it expects to fly for the first time later in 2015.

Mr Håkan Buskhe, President and CEO of the Saab Group

Christopher Chadwick, President & CEO Boeing Defence, Space & Security

Karakoram Eagle AEW&C aircraft for PAF

Production ZDK-03 AEW&C system, dubbed the 'Karakoram Eagle', one of four systems exported to Pakistan on the late-production Shaanxi Y-8 airframe

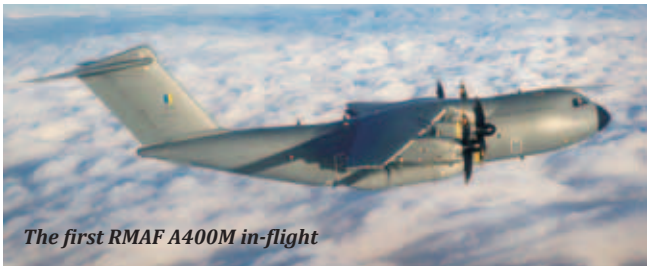
After receiving its first Karakoram Eagle 03 (KE-03) airborne early warning and control (AEW&C) aircraft three years back, the Pakistan Air Force officially inducted the type at PAF Base Masroor on 26 February, the type to be operated by No.4 Squadron. Developed by China Electronics Technology Group Corporation (CETC), this is based on a Shaanxi Y-8WG airframe and has been fitted with a rotodome. The PAF is the only operator of the ZDK-03.

Outgoing CAS, Air Chief Marshal Tahir Rafique Butt termed the induction as a significant moment for the PAF. "Re-equipping the Squadron with this state-of-the-art aircraft will enable PAF to effectively counter all threats against Pakistan's aerial frontiers and add a new dimension to National security. Induction of the Karakoram Eagle will revolutionise the PAF's operational concepts, with its induction, PAF is transforming into a modern versatile and capability-based force."

The first aircraft was produced at Hanzhong, China, on 13 November 2010 and delivered to the PAF on 26 November 2011. Since then all four KE-03s have been flown to their new base near Karachi, with the unit putting the aircraft through a lengthy test and evaluation phase that led to several minor upgrades of the original system.

First Airbus A400M for Malaysia

Airbus Defence and Space has delivered the first of four Airbus A400M military transports ordered by the Royal Malaysian Air Force, which also marks first delivery of an A400M to an export customer.



The first RMAF A400M in-flight

The aircraft was accepted at the A400M Final Assembly Line in Seville, Spain on 9 March by Chief of Malaysian Defence Force General Tan Sri Dr. Zulkifeli, in presence of Datuk Nozirah, Deputy Secretary General of Ministry of Finance, and Dato Dr. Rothiah, Deputy Secretary General of Ministry of Defence.

As Bernhard Gerwert, CEO Airbus Defence and Space, noted: "We are extremely proud to deliver the first A400M to our first export customer - Malaysia. These aircraft will transform Malaysia's air mobility force thanks to the A400M´s unique combination of strategic and tactical capabilities. This sends a clear message that the A400M is not just a specialised aircraft designed and developed for Europe's air forces, but is truly the new reference in tactical and strategic transport market globally – fulfilling both roles in a single machine."

Philippine Air Force takes delivery of its first C295

The Philippine Air Force has received the first of three Airbus C295 medium transport aircraft ordered from Airbus Defence and Space. The aircraft was formally handed over in Seville, Spain where the final assembly line is located. In Philippine Air Force service the C295 will undertake a wide variety of military and humanitarian missions.

New Pakistan Air Chief

Air Chief Marshal Sohail Aman took over as new Chief of the Air Staff, Pakistan Air Force on 19 March 2015. He was earlier Deputy Chief of the Air Staff (Operations) at Air Headquarters, Islamabad, and third senior most in the service hierarchy.

Born in 1959, he was commissioned in the GD (P) branch of the PAF in November 1980 and during his operational career commanded No.20 Squadron with F-7PGs, the Combat Commanders' School (CCS), Kamra Air Base and Central Air Command.

He has a Master's Degree in International Studies from King's College UK and a Master's Degree in Strategic Studies from the Air War College. During his career, he has been Director Operations, Director Plans and Assistant Chief of the Air Staff (Operations) at Air Headquarters, Air Officer Commanding, Central Air Command and Deputy Chief of the Air Staff (Training).

Thai Army acquires six EC145 T2s

The Royal Thai Army's rotorcraft fleet has been augmented by six light-utility EC145 T2s, the newest and most powerful model in Airbus Helicopters' proven EC145 light twin-engine helicopter family. The Royal Thai Army signed for six EC145 T2s with a VIP installation, under the Light Utility Helicopter Type II requirement, to be deployed principally for official passenger transport duties, with deliveries scheduled to begin in 2016.

New capability for Eurofighter Typhoon

(Front L-R) Alberto Gutierrez, CEO of Eurofighter and Air Vice Marshal Graham Farnell; (Back L-R) Representing Germany, General Erhard Bűhler, Director Defence Plans & Policy; for Spain Ministry of Defence, Secretary of State, Pedro Arguelles; representing the UK, Philip Dunne Minister for Defence Equipment, Support and Technology and for Italy, Lieutenant General Enzo Stefanini.

Eurofighter has received a new capability contract valued at €200 million for a suite of new enhancements to the Typhoon. Aside from introducing a number of upgrades to the Eurofighter's mission and maintenance systems, the contract *(Phase 3 Capability Enhancement)* will equip the Eurofighter Typhoon to deploy multiple precision-guided air-to-surface weapons at fast-moving targets with low-collateral damage.

The Phase 3 Enhancement contract is scheduled for delivery in 2017 and the four core nations are to work on flight control and avionics and the contract will centre round a scheduled programme of weapon testing, the development and testing of flight control systems, and finally store clearing and store release testing. The initial fit for the Brimstone 2 missiles on the Eurofighter will have two launchers fitted to the outboard pylons of the Eurofighter, each carrying three Brimstone 2 missiles. The full swing-role, multi-role weapons compliment on the Eurofighter could now include a mix of: six Brimstone 2 missiles; up to six Paveway IV bombs, two long-range Storm Shadow missiles, four Meteor beyond visual range air-to-air missiles and either two IRIS-T or two ASRAAM heat-seeking missiles.

DCNS contribution to NATO Ballistic Missile Defence

As part of a multinational industrial team led by the US Company Leidos, DCNS will participate in the system engineering and integration of NATO Ballistic Missile Defence. DCNS will provide its expertise as a naval systems prime contractor to contribute both to the definition and specification and to the integration and test of the NATO Ballistic Missile Defence architectures. NATO's aim is to integrate existing and future national weapon systems, sensors, command and control systems with the NATO Battle Management Command Control Communications and Intelligence system to provide an active defence for the protection of the alliance territory and population, as well as deployed military forces and critical assets, against a large spectrum of ballistic missiles threats.

Saab and Boeing conduct first launch of ground launched SDB

Saab and Boeing have recently tested the Small Diameter Bomb I, originally developed for use by aircraft, now adapted for launch from a ground artillery system. The Ground Launched Small Diameter Bomb (GLSDB) was integrated with the SDB I and M26 rocket motor technologies for the Multiple Launch Rocket System. The rocket motor in the test was provided by Nammo and under a teaming agreement signed last year and Boeing with Saab will offer GLSDB to current and future rocket artillery users.

MCH-101 for Japan Maritime Self Defence Force

AgustaWestland and Kawasaki Heavy Industries (KHI) have announced delivery of the first Airborne Mine Counter Measures (AMCM) equipped MCH-101 helicopter to the Japan Maritime Self Defence Force. The KHI MCH-101, a licence-built version of the AgustaWestland AW101 helicopter, is equipped with the Northrop Grumman AN/AQS-24A airborne mine hunting system and the Northrop Grumman AN/AES-1 Airborne Laser Mine Detection System (ALMDS). The development of the AMCM variant of the AW101/MCH-101 has been led by Kawasaki Heavy Industries as prime contractor, with AgustaWestland providing technical support. KHI has responsibility for system integration and design of the AN/AQS-24A carriage, deploy, tow and recovery system installed in the cabin. AgustaWestland, in addition to providing technical support, also modified the aircraft's Automatic Flight Control System (AFCS) to perform coupled towing patterns with the AN/AQS-24A.

Airbus Helicopters' partnership with South Korea

Jointly with Korea Aerospace Industries, Airbus Helicopters will develop two 5-ton class rotorcraft to meet South Korea's requirements for its next-generation Light Civil Helicopter (LCH) and Light Armed Helicopter (LAH). With these, Airbus Helicopters will continue its "highly successful relationship with Korea Aerospace Industries", including the joint programme that developed Korea's Surion twin-engine utility transport helicopter. Both the LCH and LAH will be based on Airbus Helicopters' H155 (formerly known as the EC155), the latest evolution of its Dauphin family, which includes the Panther military and parapublic variants that have demonstrated their capabilities in operation around the world.

Airbus Helicopters' Dauphin family rotorcraft – on which the LAH and LCH are based – have been delivered to more than 60 customers, with over 1,000 of these helicopters logging nearly five million flight hours in service.

W139 SAR Helicopters for UAE

AgustaWestland have delivered the next batch of three AW139 intermediate twin helicopters to the Joint Aviation Command of the United Arab Emirates (JAC), for search and rescue missions. Additional three AW139s are expected to be delivered later this year. The AW139 is also widely used for offshore transport, passenger transport, law enforcement, emergency medical transport, passenger transport and firefighting.

Airbus receives long-range surveillance contract

The Optronics business unit of Airbus Defence and Space is to supply "an undisclosed Middle Eastern country" with a large number of Z:NightOwl M combined opto-electronic and infrared imaging systems for the protection of its borders and coastlines. Z:NightOwl M consists of the third-generation thermal imager Attica M-ER with an optimal megapixel detector as well as an eye-safe laser rangefinder. It offers extreme magnification through a 200x continuous zoom and can optionally be further equipped with a near-infrared (NIR) or a short-wave infrared (SWIR) camera.

Airbus increases A320 production rate, adjusts A330 transition

Airbus will further increase the production rate for its A320 Family to 50 aircraft per month from Q1 2017, matching market demand. Additionally, Airbus is adjusting the A330 production rate to six a month from Q1 2016 as it transitions towards the A330neo.

"As an aircraft manufacturer, it is our role, for our employees, partners, customers and investors to anticipate market demands whilst delivering on orders and managing revenues," said Didier Evrard, Executive Vice President Programmes. "Given the success of the A320 Family, both CEO and NEO, we work closely with our supply chain, assess our manufacturing capabilities and decide on the most appropriate rate. On wide-bodies we are adjusting A330 production in preparation for transition to NEO while in parallel the A350 XWB is on a steep ramp-up."

ALC orders 55 Airbus aircraft

Air Lease Corporation (ALC), the Los Angeles-based aircraft leasing company, has firmed its order for 55 Airbus aircraft, comprising 25 A330-900neo and 30. ALC was first to sign up for the newest member of Airbus' widebody family, the A330neo, announcing a commitment for 25 A330-900neo. ALC was also the first to commit to the A321LR, the newest variant of the A321neo, signing an MoU for 30 aircraft in January 2015.

75th Boeing to Thai Airways

Boeing and Thai Airways have recently celebrated the Thai flag-carrier's 75th direct delivery of a Boeing airplane (a 777-300ER). Thai currently operates four 787 Dreamliners and has operated nearly every model of the 777, Thai Cargo was the first carrier in Southeast Asia to utilise the 777 Freighter, and the airline has an additional two 777-300ERs on order.

Pilatus delivers the 1,300th PC-12

On 23 February at Pilatus Business Aircraft Ltd.'s facility in Broomfield, Colorado, the Swiss aircraft manufacturer delivered the 1300th unit of its single engine turboprop PC-12 to California-based airline Surf Air. Pilatus' 1,300th PC-12 NG is Surf Air's 4th new PC-12 NG delivery since placing an order last fall for 15 PC-12 NG aircraft, with options for an additional 50. Thomas Bosshard, President and CEO of Pilatus Business Aircraft Ltd stated: "We are delighted that this milestone aircraft is going into service with Surf Air. Due to its key capabilities, its large cabin and continual development, demand for the PC-12 NG remains very high around the world." The PC-12 NG performs many roles worldwide, including executive transport, commuter, medevac, police and border surveillance, cargo transport, military liaison, and regional airliner. The PC-12 fleet has amassed nearly 5 million flight hours of operating experience, including thousands of hours in some of the world's harshest environments.

18th Sukhoi Superjet 100 joins Aeroflot

Sukhoi Civil Aircraft Company delivered the eighteenth Sukhoi Superjet 100 to Aeroflot on 20 February, 2015. The aircraft (RA–89047) was named after the pilot of World War II *Hero of the Soviet Union* Alexander Gruzdin. Since entry into service of the first Aeroflot SSJ100, the airline has logged more than 40,000 hours on this airliner and currently operates the Sukhoi Superjet 100 to destinations in Russia, Germany, Lithuania, Montenegro, Greece, Finland, Norway, Croatia, Romania, Latvia, Estonia and the Ukraine.

Sagem's WEFA system for A320

Airbus has certified the WEFA made by Sagem (Safran), intended to remotely track the situation and maintenance status of Airbus A320 commercial jetliners. Sagem's WEFA [Wireless Extension For ACMS/Aircraft Condition Monitoring System] allows airlines to remotely manage their flight data using a secure Internet connection, and therefore plan ahead for maintenance operations. Featuring a "plug and play" design, the WEFA system calls on the secure radio transmission of maintenance data collected in flight by the FDIMU (Flight Data Interface Management Unit), also supplied by Sagem. The core of the WEFA system is a 3G radio network for data transmissions between aircraft and with airports, and offers extensive processing capacity for data from the aircraft's avionics suite, prior to transmission to the ground to expedite maintenance operations.

CFM orders "soar" in 2014

In 2014, even as CFM International celebrated its 40th anniversary, the company experienced the highest levels of new engine orders and production, logging orders for a total of 4,244 engines, including 1,527 CFM56 engines (commercial, military and spares) and 2,717 LEAP engines. These orders are valued at more than US $50 billion at list price.

As the company logs record commitments, CFM is also achieving historic production rates for the CFM56 product line. The company delivered 1,560 CFM56 engines in 2014, compared to 1,502 in 2013. CFM has the highest production rate in the industry and has consistently built more than 1,000 engines per year since 2006.

Waypoint Leasing order 20 Bell 525 Relentless

Waypoint Leasing (Ireland) Limited has signed a letter of intent (LOI) to acquire 20 Bell 525 Relentless helicopters with options for additional aircraft. Waypoint plans to provide the Bell 525 Relentless to operators servicing a wide range of missions,

including oil and gas, emergency medical service, search and rescue, fire-fighting and governmental support. Waypoint's existing fleet of more than 90 aircraft includes Bell 407s and Bell 412s, both medium-lift utility helicopters.

Toll Group orders eight AW139s

Australia's Toll Group will purchase eight AW139 intermediate twin-engine helicopters, the aircraft to perform Emergency Medical Service (EMS) missions in the Southern Region of New South Wales from newly constructed bases in Bankstown (Sydney), Orange, and Wollongong and from the existing base in Canberra as part of the newly established Helicopter Retrieval Network in New South Wales.

Interjet order 10 more SSJ100s

The Mexican airline Interjet has confirmed its option for 10 additional Sukhoi Superjet 100 aircraft. In 2011 Interjet originally ordered 15 SSJ100 and 5 options. Twelve SSJ100s are currently in service with Interjet with dispatch reliability reportedly over 99%.

Bombardier CS300 maiden flight

Another major milestone in Bombardier's CSeries aircraft programme was reached with the maiden flight of the CS300 airliner on 27 February. The technologically advanced CSeries aircraft will provide operators with an all-new family of single-aisle mainline jets specifically designed for the 100- to 149-seat market segment. The CS300 airliner reached an altitude of 41,000 feet (12,500 metres) and a speed of 255 knots (470 km/h).

Airbus Helicopters unveils H160

On 3 March 2015, Airbus Helicopters presented its all-new H160, "raising the standard for performance, cost effectiveness, passenger comfort and environmental impact to create a medium-class rotorcraft benchmark." As the first product introduced with the Airbus Helicopters corporate identity and its new numbering designation, this 5.5-6 ton-class rotorcraft's "nose-to-tail breakthroughs in design and systems exemplify the company's transformation plan that puts customer satisfaction and operational safety first."

The H160 brings form and function together in a highly stylised rotorcraft, which integrates as many as 68 different Airbus Helicopters-patented technologies. "Its payload lift, range and efficiency make this helicopter ideally suited for a wide variety of uses, including oil and gas operations; public services, air medical and coast guard duties, along with commercial transport, private and business aviation." With a cruise speed of 160 kts, the H160 can carry 12 passengers at distances of up to 120 NM for oil and gas missions, and a 450-nm range with 20-minute reserve in public service or search and rescue tasks.

Rolls-Royce LiftSystems for F-35B

Rolls-Royce has been awarded three contracts to produce and support LiftSystems for F-35B Lightning II aircraft, including price reductions from prior contracts. The new contracts cover Low Rate Initial Production of 17 LiftSystems for F-35B aircraft, plus support, for two contract periods (LRIP 7-8), and were agreed between Rolls-Royce and Pratt & Whitney, the propulsion provider for the F-35 programme. The LRIP 8 contract reflects a reduction in average price per LiftSystem since LRIP 6, as Rolls-Royce continues to demonstrate success in cost reduction efforts for the F-35 Lightning II programme. LRIP7 also includes delivery of the 50th LiftFan for installation in an F-35B, as the LiftSystem continues to mature in production. The 50th LiftFan meets all Initial Operational Capability (IOC) requirements for the US Marine Corps.

nEUROn: test campaign in France

With its 100th flight made in February, the nEUROn UCAV technology demonstrator has completed its test flight campaign in France. Throughout this entire campaign, the nEUROn and associated equipment "demonstrated exemplary availability and reliability". In the first phase, the purpose of the tests was to open the flight envelope (including with weapon bay doors open), to test the electro-optical sensor and to evaluate datalink

performance. In the second phase, most flights were dedicated to infrared and electromagnetic signature/detection confrontations against operational systems.

These confrontations were performed under the authority of the French defence procurement agency DGA. The nEUROn, in full stealth configuration, was operated by Dassault Aviation which demonstrates its know-how in strategic technologies and prime contractorship, as well as its ability to lead programmes involving European cooperation. nEUROn evaluations will take place in Italy, then Sweden.

Airbus Helicopters selects X4 engine

In 2012, Airbus Helicopters launched the X4 initial design concept around two highly capable turboshaft engines options: Pratt & Whitney Canada's PW210E and Turbomeca's ARRANO. At the conclusion of this preliminary phase, and founded upon a comprehensive market assessment, Airbus Helicopters amended the product positioning, consequently necessitating a significant engine power increase. "Multiple scenarios have been studied with both engine manufacturers. Airbus Helicopters and Pratt & Whitney Canada have decided not to pursue a growth version of the PW210E engine for the X4 Programme, nevertheless, Pratt & Whitney Canada will continue to provide support until completion of the initial phase."

Norway and Australia cooperation on joint strike missile

The Australian Government's Department of Defence and the Norwegian Ministry of Defence will cooperate on further development of the Joint Strike Missile (JSM) developed by Kongsberg. Australian Minister for Defence, Kevin Andrews, said Australian cooperation on the Norwegian Joint Strike Missile, under development by Kongsberg Defence and Aerospace, would ensure the weapon capability would be available for its future fleet of F-35A Joint Strike Fighters.

The JSM long-range sea and land-target missile can be carried internally in the F-35, thus ensuring the aircraft's low-signature (stealth) capabilities. JSM development was initiated in 2008 and will be a continuous activity up until the completion of a complete product in 2017. The missile is currently in phase III of its development which will include aircraft tests, production of test missiles and integration on the F-35 Joint Strike Fighter.

Thales and Ultra Electronics partnership

Thales and Ultra Electronics TCS have established partnership to provide the next generation of high-capacity communications systems. Based on the expertise of the two leading companies in High-Capacity Line-of-Sight (HCLOS) communications, this initiative resulted in the new TN 4100 product family, which provides a suite of capabilities that significantly enhances operational flexibility and allows users to respond to the demands of current operations and beyond

Airbus D&S co-operation with Australia's DSTO

MILDS forward sensor heads, seen here in the NH90 configuration.

Airbus Defence and Space will jointly work with Australia's Defence Science and Technology Organisation (DSTO) to improve protection of wide-body aircraft and helicopters. Airbus' proven MILDS AN/AAR-60 Block II Missile Approach Warning system with a HFI (Hostile Fire Indication) capability will allow for reliable warning of the growing threat of small arms fire. As MILDS operates in the UV spectrum, it is not subject to the limitations of other warning technologies such as infrared and thus offers superior ability to detect small arms fire which is dangerous in low-level flight close to the ground.

Sagem contract with MBDA

Sagem (Safran) has signed a contract with European missile manufacturer MBDA to integrate SIGMA 30 navigation and pointing systems on several VL MICA surface-to-air weapon systems for "international markets." Sagem designed the SIGMA 30 pointing system to give air defence systems independent deployment and firing capability in the absence of GPS. The outstanding performance of the SIGMA 30 allows a distributed missile launcher deployment, which increases the mobility and protection of mobile air defence systems. The SIGMA 30 system is based on digital large ring laser gyro technology, and benefits from Sagem's proven industrial expertise in advanced inertial sensors and navigation systems. SIGMA 30 systems are built at Sagem's plant in Montluçon, France.

Thales to modernise Australian ATM

Thales has signed a framework agreement with Airservices Australia to start advanced work on a vast programme to modernise that country's Civil and Military Air Traffic Management (ATM) infrastructure. Known as the OneSKY Programme, this agreement represents one of the most far reaching ATM modernisations ever seen in Australia and is a crucial contract for Thales and for Airservices Australia.

OneSKY comes soon after the Marshall Programme, the multibillion pound sterling contract for the modernisation and operation of the UK Armed Forces ATM systems, awarded by the UK Government in 2014 to the Thales/NATS joint venture Aquila.

FAA certifies Sikorsky S-92 GWE and TCAS II

Certification of a gross weight expansion (GWE) for the Sikorsky S-92 helicopter production configuration has been given by the Federal Aviation Administration (FAA). The GWE increases the maximum take-off gross weight from 26,500 to 27,700 pounds allowing operators to carry an additional 1,200 pounds of payload. In addition to GWE, the FAA has also certified Sikorsky's S-92 helicopter integrated Traffic Collision Avoidance System (TCAS) II. Sikorsky is the first rotorcraft original equipment manufacturer to have a fully integrated Traffic Collision Avoidance System. TCAS II takes aircraft safety to the next level with the addition of visual actions that will be shown on the cockpit display as well as verbal guidance given to the pilot that advise actions to take to avoid a collision (ascend, descend, etc.). Meanwhile, Sikorsky has recognised Bristow Helicopters Ltd.'s upcoming launch of the UK search and rescue (SAR) contract and the company's dedication to SAR over the past 40 years. Bristow's S-92 helicopters will operate from five bases strategically located near areas of high SAR incident rates in the UK.

Sikorsky S-97 Raider progresses

Sikorsky has started final assembly of the second S-97 Raider helicopter at the company's Development Flight Centre so as to demonstrate the revolutionary new capabilities in improved manoeuvrability and flight speed. The Raider is a rigid coaxial rotor prototype aircraft ideally suited for armed reconnaissance and a spectrum of special operations missions. Sikorsky launched

the S-97 Raider programme in October 2010 with the objective of maturing the X2 rotorcraft design and offering a helicopter to meet US Army armed reconnaissance and special operations needs. The company developed the first Raider prototype as a test aircraft, built to prove the military application of Sikorsky's X2 Technology. The second prototype will serve as a demonstrator aircraft, offering key customers an opportunity to experience the capabilities of X2 Technology first hand.

Safran's 2014 results

Chairman and CEO of Safran, Jean-Paul Herteman has stated: "Safran once again made strong progress in 2014. Backlog is at a record level, revenue grew 7% and profitability increased 17%, as we hit record production rates in many areas. Free cash flow grew year on year even as we are dedicating unprecedented resources to meet the operational challenges of that commercial success and as we intensively prepare our medium for a long term future. Safran's past investments were rewarded this year with a number of significant successes on prestigious platforms for our helicopter turbines, our civil aero engine technologies or our nacelles."

Safran's new order intake during 2014 was €23 billion, providing evidence of robust and resilient demand. The backlog grew to €64 billion compared to €55 billion last year. This does not include future flows from CFM56 spares and services provided on a "time and materials" basis which will provide significant high-margin revenue streams in future decades.

Maiden flight of the P.1HH HammerHead prototype

Finmeccanica – Selex ES have contributed to the maiden flight of the prototype 001 of the Piaggio Aerospace P.1HH HammerHead, after an extensive flight campaign carried out with the P.1HH demo technology demonstrator, at the Italian Air Force base of Trapani Birgi. The prototype flew with the Finmeccanica – Selex ES' new vehicle control and management system for the first time and was remotely operated from the Finmeccanica – Selex ES ground control station (GCS), via the company's datalink and communications systems to ensure safe operations during all flight activities. Finmeccanica – Selex ES also cooperates with Piaggio Aerospace to ensure highly effective integration.

The P.1HH HammerHead mission management system is based on the Finmeccanica - Selex ES' SkyISTAR platform-agnostic

innovative solution designed for patrol and ISR missions. The system is capable of responding to diverse threats that range from terrorist attacks to illegal immigration, protection of Exclusive Economic Zones, infrastructures and critical sites. SkyISTAR built-in sensor fusion, data management and exploitation features of skyISTAR enable highly effective border control, wide area surveillance, targeted surveillance, environmental and disaster control missions.

Finmeccanica/ Selex ES awarded new Grifo radar contracts

Finmeccanica/ Selex ES has been awarded two important new contracts for the Grifo radar system which can be installed in a large range of combat aircraft and integrates easily with modern avionics suites. The Grifo family of airborne fire control radars are multimode and operate in the X-band, offer a broad suite of field proven air-to-air, air-to-surface and navigation modes, high resolution SAR and ISAR. Over 450 of the radar systems have been sold so far and the radar equips six international Air Forces, including Pakistan's. The radars, manufactured at the company's Nerviano (Milan) site in Italy, are in service with seven types of aircraft and have accumulated over 150,000 hours of operational flight time.

MBDA resumes growth

MBDA has registered an order intake of €4.1 billion in 2014, a slight improvement on the figure achieved in 2013. Export orders accounted for €2.5 billion of this 2014 result, thereby exceeding domestic orders as was also the case in 2013 and 2012. As expected, sales dropped to a low of €2.4 billion in 2014, reflecting the budgetary cuts that MBDA's domestic countries have been carrying out over several years. Moving on from 2015, this figure should see a significant rise as an effect of the exceptional level of orders received over the last two years. At €12.6 billion at year end 2014, the order book now represents more than four years of activity at current levels and will allow MBDA to return to a condition of growth in the mid-term.

Antoine Bouvier, CEO of MBDA stated that, "2014 also saw important advances being made with our key programmes. The MdCN naval cruise missile successfully completed its final qualification firing. The land combat missile, MMP, successfully carried out its first firings. Increasingly complex firings served to demonstrate the maturity of Aster in service with the armed forces. Contractual obligations within the development programme for MEADS, the extended air defence system, were concluded through demonstrations of both the system and its MFCR multi-function radar. Good progress with the Sea Ceptor naval anti-air missile system allowed MBDA to launch studies on the ground variant known as FLAADS Land. Finally, with the integration of MBDA's Storm Shadow, Brimstone and Taurus missiles starting on the Eurofighter Typhoon, new export opportunities are being opened up for our air-to-ground weapon systems".

Nexter Group's new VBCI

Nexter has unveiled a VBCI IFV fitted with the T40 turret, which is equipped with the 40CTAS, a 40mm cannon developed by CTA International and recently qualified and selected by the French Army for its future Jaguar reconnaissance vehicle and by the British Army for its Scout programme. The VBCI is "combat proven", already deployed in Lebanon (2011-), Afghanistan (2010-2012), Mali (2013-), and Central African Republic (2014-). Nexter has presented its latest 6x6 versatile armoured vehicle, the Titus. In addition to this complete armoured vehicle offer, Nexter presented its know-how in artillery systems with CAESAR self-propelled 155mm/52 cal. howitzer, used by the French Army in Lebanon, Afghanistan and Mali, and the 105mm Light Towed Gun 105LG1 which is in service with six different armies.

DCNS to supply FREMM frigate to Egypt

DCNS has signed a contract with the Egyptian Ministry of Defence for the supply of a FREMM multi-mission frigate, which agreement strengthens the strategic relations initiated by DCNS last July with the signing of a contract to supply four Gowind 2500 corvettes. The frigate (current *Normandie*) will be delivered mid-2015 after some outfitting work, and the first phase of the training programme. The logistics and support services provided to the Egyptian Navy will then continue over several years.

VAYU's 4

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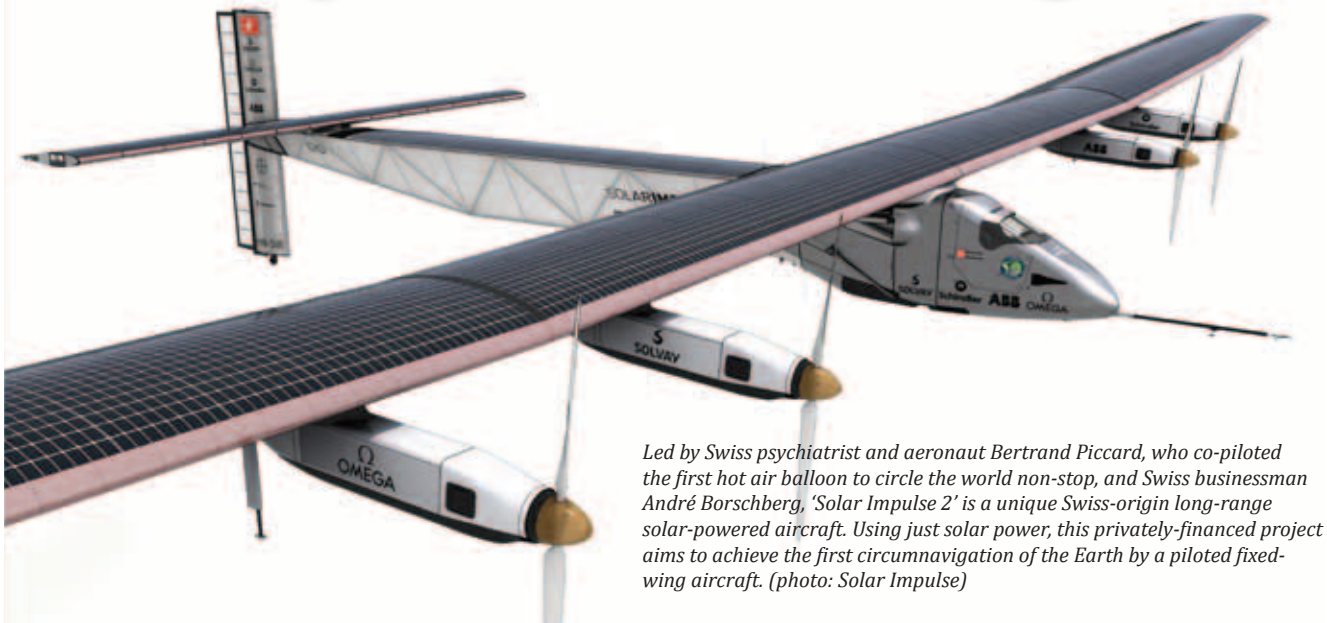
Solar Impulse 2 wafts through India



Led by Swiss psychiatrist and aeronaut Bertrand Piccard, who co-piloted the first hot air balloon to circle the world non-stop, and Swiss businessman André Borschberg, 'Solar Impulse 2' is a unique Swiss-origin long-range solar-powered aircraft. Using just solar power, this privately-financed project aims to achieve the first circumnavigation of the Earth by a piloted fixed-wing aircraft. (photo: Solar Impulse)

Solar Impulse's arrival in India made the headlines alright, with its Pilot Bertrand Piccard, accorded a traditional, even exuberant, welcome with garlands and much media coverage. However, what made even more headlines was his distress in not being cleared to leave on the next leg because of bureaucratic delays in simply acknowledging that he had actually landed in India, since his passport had not been stamped !

As Bertrand Piccard rued, "When I arrived here with solar Impulse, there were authorities, media and ceremony. I was covered with garlands and shawls and I missed immigration clearance. And now I am desperate ..." However, on 18 March the paper work was complete and they were on their way again.

15 years earlier, Piccard and his then co-pilot Brian Jones had been the first to make a nonstop balloon flight around the world in 1999. Reflecting upon the instability of such a flight's dependence on fossil fuels, Piccard soon resolved that his next flight around the world would be free of fuel and emissions. Thus, the inspiration of a solar airplane was born.

The first such aircraft, bearing Swiss registration HB-SIA and christened 'Solar Impulse 1', is a single-seat monoplane, takes off under its own power and designed to remain airborne up to 36 hours. This aircraft conducted its first test flight in December 2009 and first flew an entire diurnal solar cycle, including nearly nine hours of night flying, which was a 26-hour flight on 7-8 July 2010. Piccard and Borschberg had completed successful solar-powered flights from Switzerland to Spain and Morocco in 2012, and then conducted a multi-stage flight across the USA in 2013.

Registered as HB-SIB, a slightly larger follow-on design known as 'Solar Impulse 2', was built and first flown in 2014. In March 2015, it began a circumnavigation of the globe, departing Abu Dhabi in the United Arab Emirates on 9 March and scheduled to return there five months later, covering 22,000 miles (35,000km), including its India sector (where their brush with Indian bureaucracy has already been mentioned).

First landing was in Muscat, Oman which took around 13 hours. Thereafter, crossing the Arabian Sea from Oman to India (a distance of 1,468 kilometres) Bertrand Piccard set a new distance record for a flight in a piloted solar-powered aircraft, having taken off on 10 March at 06:35 local time and landing at 23:25 at Ahmedabad.

As this goes to press, 'Solar Impulse 2' had completed the India leg of its journey, and will continue through Myanmar to China, the USA and then either southern Europe or northern Africa, before returning to its point of departure in Abu Dhabi.

Borschberg and Piccard are alternately flying the aircraft, which has an electronic co-pilot during brief rest breaks. Both pilots underwent rigorous training to prepare for the trip, including yoga and self-hypnosis, allowing them sleep in bursts as short as 20 minutes. Whilst airborne, the pilots are linked to a control centre in Monaco where weathermen, air traffic controllers and engineers are stationed.

On arrival at Ahmedabad airport (photo: Solar Impulse-Jean Revillard)

On the subject of the aircraft, Sanjay Kumar, chief executive and managing director of Altran India, an Indian Engineering Consultancy firm involved in the design of the Solar Impulse project said, "It is all about possibility and probability. There is predictive analysis that goes in there, but the communication in this plane is still quite basic."

Solar Impulse 2 is most definitely the "bold experiment" that Mr. Kumar says it is, but more importantly, it is an attempt to change the aerospace industry as we know it. "With Solar Impulse, we want to show that we can still achieve big dreams, or at least take the risk of trying," said Piccard. "Maybe we'll fail. But the worst is not to fail. The worst is to be afraid of trying."

Dutch port call for PLA Navy warships

Between 26 and 30 January 2015 the Port of Rotterdam hosted a Chinese People's Liberation Army Navy (PLAN) task force, in a historical first visit by PLAN warships to a port in the Netherlands. The PLAN's 18th Escort Task Group comprised three vessels: a Type 071 (*Yuzhao*-class) amphibious transport dock (LPD) '*Changbai Shan*,' a Type 054A (*Jiangkai II*-class) guided missile frigate '*Yuncheng*' and a Type 903A (*Qiandaohu*-class) supply ship '*Chaohu*.' There were three helicopters (two Changhe Z-8J and one Harbin Z-9C) embarked by the three visiting vessels, and crew consisting of some 100-odd special operations personnel and over than 800 officers and sailors.

Before Rotterdam, the ships had made port calls at Hamburg in Germany, Salalah in Oman and Portsmouth in the UK. After Rotterdam the ships continued to France and Greece on their European tour. These port calls came after completion of a four-month counter-piracy escort mission in the Gulf of Aden, which ended in late December 2014.

China has been involved in anti-piracy operations ever since 2008 with the 19th Escort Group currently deployed. China sent its first convoy fleet to the Gulf of Aden area in December 2008, and a total of 19 fleets have escorted more than 6,000 Chinese and foreign vessels and rescued or aided more than 60 other ships since then.

Till date the PLA Navy escort task force has fulfilled 800 escort missions in the Gulf of Aden.

The PLAN has also conducted other missions, including searching for the Malaysian Airlines flight 370 that went missing in March 2014 and assisting the Philippines and Indonesia with disaster relief.

The three helicopters embarked with the warships are deployed to support task force operations. The Z-8Js are locally made Aerospatiale SA 321 Super Frelon heavy transport helicopters, in service since the late 1980s. China acquired thirteen Super Frelons in the 1970s, in both anti-submarine warfare (ASW) and search and rescue (SAR) versions. Since the 1980s, Z-8s have been frequently used by the PLAN for ship borne Anti Surface Warfare (ASW) and Search and Rescue (SAR) operations. For ASW missions, the Z-8 is equipped with surface search radar and a French HS-12 dipping sonar while carrying a Whitehead A244S torpedo under starboard side of the fuselage. The aircraft are also used to ferry supplies from replenishment ship to surface combatants, and transport marines from a landing ship to shore. A naval SAR version called the Z-8S with upgraded avionics, searchlight, FLIR turret and a hoist flew in December 2004. Another rescue variant with dedicated medevac equipment on board was also developed for the Navy as the Z-8JH. It is understood that over a hundred of the type are currently in service.

Besides the Z-8Js, a sole Harbin Z-9 (NATO reporting name '*Haitun*,' Chinese for Dolphin) was also part of the visit. This is a licence-built Eurocopter AS 365 Dauphin, with first deliveries commencing in 1994. Over two hundred Z-9s are believed to be in service today in various variants. The naval version introduced in the 1990s is known as the Z-9C, and is comparable to the Eurocopter AS 565 Panther. As well as SAR and ASW duties, the Z-9C can be fitted with an X-band KLC-1 surface search radar to detect surface targets beyond the range of ship borne radar systems.

Carlo Kuit and Paul Kievit/
[Bronco Aviation]
All photos from Bronco Aviation

Lindbergh's Miles Mohawk at RAF, Hendon

Anand Sethi writes about ...

.... a Magnificent Man, his Flying Machine, Aviator Wife and a Famous Explorer in tow

Colindale is one of the smaller Tube stations on the London Underground, on the Edgware Branch of the Northern Line. As you exit the station, a short walk brings you to Graham Park Way. You are now in a world quite different from the crazy traffic of the nearby North Circular Road, the M1 motorway and the milling crowds of the Brent Cross Shopping Centre, England's very first shopping mall. One has now arrived at the Royal Air Force Museum, RAF Hendon, located at what was once London's Colindale aerodrome. Unfortunately Colindale was never London's airport, that honour in history went to Croydon.

There are five major buildings at RAF Hendon, including the Graham–White Factory, England's very first Aircraft factory now lovingly relocated. However, the building of particular interest to us is the 'Milestones of Flight Building'. This hangar has many venerable and historic aircraft, Gloster Meteor, Bleriot XI, Mosquito B35, Typhoon, Harrier to name just a few. Amongst all these famous aircraft is parked a tiny little machine (British Registration G-AEKW) that you may miss on the first pass but for its extraordinarily striking black fuselage and shocking orange-coloured wings.

The RAF Hendon documentation describes the aircraft as a Miles M-12 Mohawk 'all-wood tandem two-seater with dual control.' It is a custom designed *(Designer: FG Miles)* machine built in 1936 to the demanding specifications of a truly fussy aviator. It has 'fixed spatted undercarriage slim line Lockheed struts, Airdraulic shock absorbers, an advanced Menasco Buccaneer B6.S (Sl. No. 6046) inverted air cooled six cylinder engine of 200 horsepower, glazed panels which slide downwards to rest inside the fuselage, and Miles split flaps to lower the landing speed.'

Further, the aircraft with a top speed of 200 mph and a range of 1400 miles has a special compartment immediately behind the rear seat where luggage, a collapsible dingy, a tent and other survival equipment could be stowed. The seat cushions and back rests are removable and become an 'alfresco' bed! It has provisions for three parachute flares made by the Flare Signal Co. of Ohio fitted in the rear of the fuselage from where they could be fired electrically to illuminate a landing ground at night.

Well the title sort of gives the game away! G-AEKW Miles M-12 Mohawk was custom built for its first owner, the legendary Charles Lindbergh, by Philips & Powis Aircraft Ltd. at Woodley (near Reading). Lindbergh wanted a "fast, long range light touring aeroplane" in which

he and his wife, Anne Morrow Lindbergh could make business trips around Europe and elsewhere. Incredibly this was the only Mohawk ever to be assembled.

RAF Hendon records indicate that the aircraft was registered on 14 July 1936. It made its first flight of 15 minutes on 22 August 1936 with the designer, FG Miles at the controls and a further flight of 15 minutes later that afternoon with Charles Lindbergh himself at the controls. On 18 November 1936, Lindbergh flew his aircraft to Ireland to test the, as yet unfinished, airport of Shannon near Limerick. History then records that the next day, he gave a flight to the President of Ireland and the father of that nation, Eamon de Valera, who apparently had never been on an aircraft before.

The aircraft, however, received its Certificate of Airworthiness only as late as 28 January 1937 apparently owing to problems with the sliding cockpit hood sections which had to be remanufactured. G-AEKW was officially handed over to Charles Lindbergh on 1 February 1937.

It has of course been widely known for long that Charles and Anne Morrow Lindbergh were exasperated with media attention after the abduction in March 1932 of their 20-month old son, Charles and his subsequent murder in May the same year. Worried about the safety of their second born son Jon, the Lindberghs relocated to Sevenoaks Weald in Kent, England at the end of 1935. It has also been widely known that Charles Lindbergh made trips into Europe in 1936 and especially to then Nazi-controlled Germany, some say as a sort of Intelligence operative for the US Government.

In the then somewhat more conservative England, the Lindbergh's privacy was respected and the media by and large let them be. Yet being world renowned celebrities, they were well introduced in the uppermost strata of British society including the Royal Family, members of Parliament and others. In 1936, Charles Lindbergh made contact with that old India and Tibet expert, Murree-born Sir Francis Younghusband, 'The Last Great Imperial Adventurer, soldier, explorer, mystic, guru and spy', as the famous writer and historian Patrick French described him.

What follows is some extraordinary information that I picked up quite by fluke. Over the past year or so I had been researching archival information, records, photographs,

Charles Lindbergh manually re-fuelling his aircraft, possibly at Jodhpur. Notice the pith helmet (Courtesy: Yale University Library)

and any trivia with a connection to the geographical area where we live, Dagshai/ Kasauli in Himachal Pradesh. Information relating to Sir Francis Younghusband was well near the top of my wish list. Sir Francis fell in love and almost married May Ewart, daughter of the Deputy Brigade Commander of Kasauli in 1889. The Kasauli Club has a hall named after the famed explorer.

The British Library and the National Institute of Social Work Archives, both in London have a wealth of information, copies of correspondence, photographs and records on Sir Francis. My research seemed to indicate that Charles Lindbergh established contact with Sir Francis to seek guidance and help with Lindbergh's quest for spiritual pursuits and 'supersensory phenomena' – having been so shaken by his son's kidnapping and murder.

Sir Francis Younghusband, a bit of a 'cad' in his younger days, a diehard imperialist with the reputation of being the 'butcher of Tibet', had also turned religious (as well as a strong supporter of Indian independence) in his later life. In 1936 he founded the World Congress of Faiths, a global organisation based in England promoting inter faith dialogue. To quote from Patrick French's book, Charles Lindbergh "expressed a wish to find fakirs and fire–walkers and squat with a yogi".

Sir Francis was to leave for India to attend the World Parliament of Religions in Calcutta in February 1937. Charles Lindbergh suggested to him that he and his

All set to leave Jodhpur (Courtesy: Yale University Library)

wife Anne Morrow could meet up in India, "to have the opportunity of meeting even a few of the Indian mystics and religious men, I feel that alone would be worth the trip."

So, did they come to India?

Now we know that Sir Francis made the journey in 1937 to Bombay by sea. But what of the Lindberghs ? I started nosing around a bit more. The first input came from RAF, Hendon. Shortly after the official handing over on 1 February 1937 of the Miles Mohawk aircraft to Charles Lindbergh, he filed a flight plan ex Woodley heading to Rome later that day.

Researching the Lindbergh archives repository at Yale University and US newspaper archives of that period through a little used site *(news.google.com/newspapers/archives)* I came across some extraordinary information. Bingo ! The Lindberghs had indeed flown their Miles Mohawk, G-AEKW, to India. They landed in Pisa, Italy on 2 February 1937 and in Rome on 3 February 1937.

Stopping off and sightseeing on the way, the Lindberghs made their way to India. The sequence of events being:

20 Feb. 1937: Land in Karachi, and take off for Jodhpur after 55 minutes. *(Reported by United Press, datelined Karachi, 20 Feb.1937)*

20 Feb. 1937: Arrive in the evening at Jodhpur. Stay and rest for two nights. (*Reported by 'The Pittsburgh Press', datelined Jodhpur, 20 Feb.1937)*

22 Feb. 1937: Depart Jodhpur at 13.50 for an 'UNKNOWN' (for security reasons) destination. *(Reported by United Press, Jodhpur on 22 Feb. 1937)*

24 Feb. 1937: Lindberghs land at Bombay at 13.00 from the 'unknown' place. *(Reported by A.P for 'The Evening Independent', datelined Bombay, 24 Feb. 1937)*

24 Feb. 1937: 'Unknown' place of Lindberghs visit identified as Udaipur. *(Reported by 'The Milwaukee Journal', datelined Bombay, 24 Feb. 1937)*

24 Feb. 1937: Charles Lindbergh meets Sir Francis Younghusband in Bombay. *(Reported by 'The Pittsburgh Press', datelined Bombay, 25 Feb. 1937)*

25 Feb. 1937: Charles Lindbergh flies Sir Francis Younghusband to Kamptee (Nagpur). Charles Lindbergh returns to Bombay in the evening. (*Reported by 'The Pittsburgh Press', datelined Bombay, 25 February 1937)*

25 Feb. 1937: Aviation authorities in Bombay ask Lindbergh to inform them in advance of flight plans. His response "I never give notice in advance. I am confident of my flying equipment." *(Reported by 'The Miami Herald', datelined Bombay, 25 Feb.1937)*

26 Feb. 1937: Lindberghs depart Bombay at 07.30 for Kamptee (Nagpur). Anne Morrow Lindbergh deplanes and stays on in Nagpur. *(Reported by AP / 'Lewiston Daily Sun', datelined Bombay, 26 Feb. 1937)*

26 Feb. 1937: Charles Lindbergh flies Sir Francis Younghusband from Kamptee to Calcutta and not his wife, perhaps because deadly storm hits Calcutta area.

27 Feb. 1937: Charles Lindbergh flies from Calcutta to Kamptee. Drives to Nagpur. *(Reported by AP / 'Reading Eagle', datelined Kamptee Airdrome, 27 Feb.1937)*

28 Feb. 1937: Newspaper reports that the Lindbergh's plane had developed some

Getting ready to start the engine. Most likely at Delhi. From the 'Milwaukee Journal', datelined New Delhi, 24 March 1937

Charles Lindbergh spent most of his youth in relative obscurity, until his historic solo transatlantic crossing by air. An US Army Air Corps Reserve officer, he was only twenty-five when he took off from Roosevelt Field in Long Island, NY in a purpose-built Ryan monoplane called the '*Spirit of St Louis*' and landed 33 hours and 30 minutes later at an airfield called Le Bourget, some seven miles northeast of the city of Paris. Six notable aviators had lost their lives attempting this feat that catapulted the young pilot into instant world fame.

Although initially opposed to US participation in the Second World War, Lindbergh flew combat missions in the Pacific Theatre after the Pearl Harbour attack in December 1941.

In later life, Lindbergh played an active role in the development of military and civil aviation in the USA, and also authored a number of prize-winning books on subjects ranging from aviation to environmentalism.

The Lindberghs with a family in Calcutta. Anne Lindbergh has on a traditional Bengali head decoration. The foreign gentleman with a garland looks like Sir Francis Younghusband. (Courtesy: Yale University Library)

problems. Hence they would take a train to Calcutta with the Miles Mohawk staying in Kamptee *(Reported by AP/'St. Petersburg Times' datelined Nagpur, 28 Feb.1937)*

(Authors note: Looks as if this was a deliberate 'red herring' so that reporters would not be at Calcutta Airport on 1 March the death anniversary of their late son).

1 March 1937: Another 'Red Herring' report that the Lindberghs arrived in Calcutta by train. *(Reported by 'The Day', and 'Tuscaloosa News' datelined Calcutta, 1 March 1937)*

1 March 1937: Lindberghs fly into Calcutta. For reasons of safety they stay with the US Consul. *(Reported by the 'Tuscaloosa News' datelined Calcutta, 2 March 1937).*

2 March 1937: Dinner with a rich (unidentified) Bengali family.

3 March 1937: Dinner at the 'Great Eastern Hotel', Calcutta. Attended by Charles & Anne Lindbergh, Sir Francis Younghusband, David Macdonald (interpreter during the Younghusband Tibet expedition), Gedun Chophel (famous Tibetan scholar), Geshe Sherab Gyatso (famous Tibetan monk), Ngak Chen Rinpoche (Prime Minister to Tashi Lama was stand in for the Dalai Lama during Younghusband's Tibet expedition).

4 March 1937: Charles and Anne Morrow Lindbergh are special guests at the 'Parliament of Religions' meet in Calcutta. Mrs. Sarojini Naidu, praises Charles and compares him to "Buddha, Galileo and the other spiritual figures of the world." News reports state that Lindbergh blushed red and pink!

(Reported by the 'Milwaukee Journal' datelined Calcutta, 4 March 1937).

5 March through 21st: (Author's note: Incredibly, there seem to be no records of the Lindberghs in India for this period).

22 March 1937: The Lindberghs are lunch guests at Delhi of the Viceroy, Marquess of Linlithgow. *(Reported by 'The Telegraph' datelined New Delhi, 22 March 1937).*

24 March 1937: Departure from Delhi for Jodhpur and Karachi and onwards back to Europe. *(Reported by 'The Pittsburgh Press' datelined New Delhi, 24 March 1937.*

11 April 1937: Arrive back in England via Belgrade on 12 April 1937.

Post–India trip history : Miles Mohawk G-AEKW

The Lindberghs returned to the United States in April 1939. G-AEKW was dismantled and stored at Woodley aerodrome under the charge and care of Phillips & Powis Aircraft Ltd. The aircraft was then presented to the British Government on the outbreak of World War II.

In October 1941 the aircraft was removed from storage, reassembled, painted with RAF camouflage colours and test flown by a Flt Lt WG Capley. On 8 November, 1941 the aircraft was formally inducted into the Royal Air Force. The RAF used it as a communications machine in the Comm. Squadron. After the war the aircraft was put into storage at RAF Kemble and in May 1946 was sold off to Southern Aircraft (Gatwick) Ltd.

Southern Aircraft reconditioned the machine and put it up for sale. It was first bought by a Mr Ernest GF Lyder who then sold it in May 1948 to Mr Bruno Pini, a member of the Broxbourne Aero Club. Sadly the aircraft crashed on landing at Adra, Spain. It was being flown by Mr Pini who was returning from an International Air Rally. That was to be the last flight.

Until 1973 the remains were lying at a Spanish scrap yard where they were located by an American enthusiast, Wilson Edwards. In November 1975, Lew Casey, the curator of the US National Air & Space Museum, acquired the remains and had the machine partially restored.

In July 2000 the aircraft was donated to the Royal Air Force Museum, Hendon. The RAF had the aircraft faithfully restored by Skysport Engineering, Hatch (Bedfordshire) and in August 2008 it was formally put in as an exhibit in the Milestones of Flight Building at RAF, Hendon, now awaiting Indian air enthusiasts !

The Winged Warrior in his Valhalla

Remembering Major General Atma Singh : "Father of Indian Army Aviation"

As Lt Colonel, Atma Singh, had commanded an AOP Squadron

In the presence of Major General Atma Singh, one was inevitably transported to those fateful days of December 1971 when as Major, Atma Singh played a heroic role amidst other critical factors at the crucial battle of Laungewala on 5 December 1971. Other dramatic personae on that desert stage were the Pakistani infantry brigade, led by an armoured regiment of T-59 tanks, and their nemesis, a handful of IAF Hunters from Jaisalmer.

Commanding a flight of five HAL-Krishak AOP aircraft, Atma Singh - and his colleague Captain PS Sangha - directed Hunters against the tanks, sortie after sortie, attacks which decimated the enemy. This was indeed the way it was, the real truth as described in General Atma's words, even though the truth would sometimes hurt.

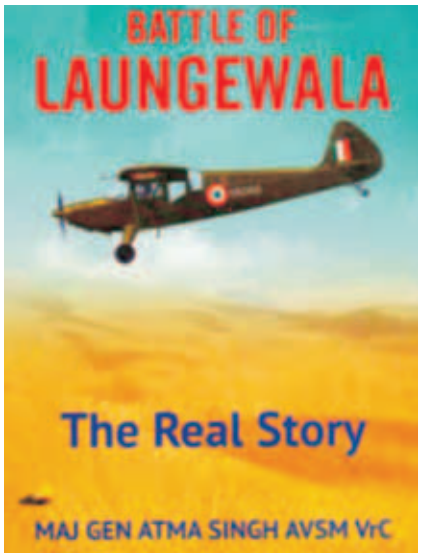
Regarded as the 'Father of Indian Army Aviation', Major General Atma Singh, had written a brilliant chapter in the history of Indian Army Aviation and won for himself, and Captain PS Sangha, Vir Chakras for gallantry.

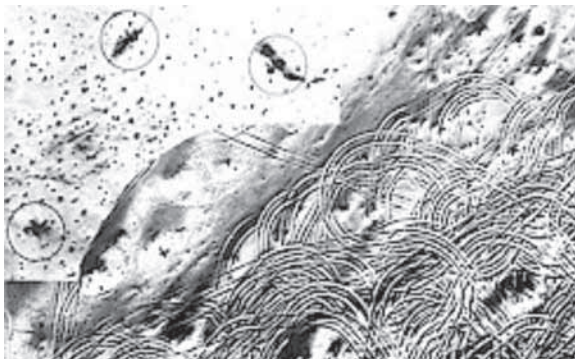
Atma Singh was a brave heart indeed, with exemplary grit and determination having superb dedication to duty, exemplified by his retrieval of his force-landed Krishak aircraft in the face of enemy fire and flying it back to base. It was a daunting task and he rose to the occasion in his inimitable manner, disregarding personal safety.

After retirement he authored a book on his focused subject, army aviation *'Unarmed into Battle- Story of Air Observation 1794-1986'.*

For us at *The Society for Aerospace Studies*, which had the privilege of editing and publishing the General's book titled *'Battle of Laungewala : The Real Story'* in 2013, encapsulated his indomitable spirit and utter disregard for age-related infirmities that characterised his life. Driving his car all the way from Rohini to Sujan Singh Park, unaided by an assistant, he would slowly but surely climb up the steps and spend hours going over manuscript of the book, incorporating corrections and selecting appropriate visuals. Increasingly frail and not firm on his feet, he still sought no help and then drove home alone. That was the indomitable spirit of Major General Atma Singh.

On 7 February 2015, Major General Atma Singh passed away in New Delhi, after an illness bravely borne. While Atma Singh will forever be remembered for his valiant role in Laungewala, his chequered career in the Army is worthy of emulation. Commissioned in the Regiment of Artillery on 2 June 1955, Major General Atma Singh was nominated for the Air OP course in 1962, followed by the Flying Instructor Course in 1966. During his 34 years in uniformed service, he performed regimental service for 16 years, which included Command of a Field Regiment, Deputy Command of an Independent Artillery Brigade and the Command of an Artillery Brigade.





He served in Air OP units/Army Aviation for eight years during which he commanded various independent Air OP flights, 659 and 665 Air OP Squadrons, and was Brigadier Aviation at Army Headquarters before becoming the first ADG Army Aviation

From 1973 onwards, he had been involved in the study, preparation and presentation of cases pertaining to the formation of Army Aviation. In 1984-85 he visited the UK, France and Italy to assess the Army Aviation Corps of these countries. After the government took the decision to create the Army Aviation corps, he prepared blueprints for its organisation, technical/logistic support and approach for assuming all Air OP assets from the Air Force. He was the first Additional Director General (ADG) Army Aviation from November 1986 to November 1988.

He was honoured with the Ati Vishisht Seva Medal on 26 January 1987 for "distinguished services leading to the formation of the Army Aviation Corps".

Major General Atma Singh will forever remain an Army Aviation icon, and continue to inspire present and future generations of Army Aviators.

Group Captain (retd) JC Malik VSM

Three Significant Air Experiences

CTU Hakimpet : 28 October 1952

On that date, as a newly commissioned young Pilot Officer undergoing fighter conversion, with great difficulty I was able to bail out of a blazing Tempest aircraft HA 596. It was my first face to face encounter with imminent death and the experience influenced my future learning and teaching, lending credence to Murphy's law that 'if anything can go wrong, it will'. The only other recorded successful bail-out from a Tempest in the IAF was in 1948 (Flt Lt Noronha). Currently I am the oldest living Indian member of the Caterpillar Club.

In a letter dated 21 July 1994 to me, then-ACM Arjan Singh DFC wrote: "You were lucky to get away with it in a Tempest, a difficult aircraft to fly and land much less to bail out of…"

OTU Jamnagar : 1966-69

As a newly promoted Wing Commander, I raised and commanded the IAF's first Hunter-equipped Operational Training Unit at Jamnagar. This, our seventh Hunter unit, was created from resources allotted (read: begged, borrowed or stolen) from the existing six Hunter squadrons. It was my greatest learning experience in the innovative procurement and management of resources (human/material), time and quality control. Though the Air Force recognised my effort by the award of the VM, my greater reward was the superb professional performance of my young pilots in the 1971 Indo-Pak war, many of whom rose to high ranks/appointments. 48 years later the unit continues its training role equipped with MiG aircraft.

In a letter dated 8 November 2003, Air Commodore PM WilsonVrC, ex-Station Commander Jamnagar 1968-72 wrote, "Nosey your great work in OTU in 1966-69 paid off in 1971…"

No. 20 Squadron, Pathankot : December 1971

Of the 128 sorties flown by No.20 Squadron from 4 to 15 December 1971, most of the counter air missions were led by me personally as the CO. None were however more dramatic, dangerous and daring as the first gun strike on Peshawar PAF airbase at sunrise on 4 December1971. My own squadron's aircraft, pilots and technicians were in night harbour at Ambala on 3 December and I was alone at base with two young pilots. I was ordered to carry out a two-aircraft mission with two Hunter Mk.56A aircraft from our sister squadron on base. My young wingman coped excellently including his very first night take-off. We were lucky to carry out the attack and get away from a number of Sabre aircraft on CAP, which then chased us as far as Akhnoor, where we had to face ground fire from both sides as the land battle commenced. We landed with 22 hits on my aircraft and four on his with both aircraft flaming out on the taxi track after landing. The Rashtrapati conferred the MVC on me but No. 20 Squadron continues to be the most highly decorated squadron in IAF.

A highly decorated pilot and air officer from the PAF was my colleague at the RCDS London in 1980. Reminiscing over the air operations of 1971, he commented: "Your guys were nuts to put Hunters into Peshawar when they did and you were very lucky" I assured him that our luck was earned by thorough training and unconventional tactics applied with IAF jugaad!

Army Air Co–op

In early October my wife and I were invited to an Air Force Day function to mark the 82nd anniversary of the IAF. The party was hosted by and held at an air base I had commanded 39 years ago. The Officers' Mess looked quite splendid with its lighting, decoration, ceremonial uniforms of the Army, Navy, Air Force and colourful attire of the ladies. Being the same age as the Air Force, I was apparently the oldest guest present. All the invited air veterans (each of whom had served earlier at this very base) were personally welcomed and felicitated by the AOC.

Age has its privileges and, apart from our host who ensured constant hospitality, small groups of young officers and their wives (no doubt discreetly propelled by the PMC) came to keep us company. This social interaction with the present young generation, most of whom were in the age group of our grandchildren and some of whom were themselves service children, helped us understand the many changes that constantly take place. Since I have a hearing disability, I was relieved to have my wife by my side to amplify my audio reception!

One such group had a very friendly, articulate and perceptive young Air Force wife who, having spotted my hearing aid, spoke slowly and clearly much to my relief. She and her husband were to move shortly on their first posting and were awaiting the packers and movers. In response to her queries on similar experiences while in service, I explained that in our near 59 years of marriage, the first 30 had been spent in the Air Force and involved 16 'permanent' moves for which my wife was the packer and I was the mover!

The young lady smiled, told us she herself was the daughter of an Army officer and felt that army officers' wives were very fortunate as they had their husband's batman to help them and wondered why the Air Force did not have the same facility? With a straight face I told her that in my experience, Air Force wives were far luckier. She challenged me to substantiate that claim much to the amusement of our group. I responded that, though Army officers' wives were fortunate to get the help of a batman, Air Force wives soon found that they were married to trained batmen and hence had no requirement for this facility. She cheerfully joined in the laughter that followed this quip but this quick-witted *fauji beti* had the last word by declaring, "Sir no doubt you are right but I do wish their training had been done by the Army and not just left to their mothers!" Touché, young lady.

Air Vice Marshal Cecil Parker (retd.)

25 Years Back

From Vayu Aerospace Review Issue II/1990

HAL-Dornier 228 Maritime Patrol Aircraft

Pioneered by the Indian Coast Guard which selected the Dornier 228 for meeting its multifarious tasks, including surveillance of the EEZ, anti-pollution operations, search-and-rescue, cas-evac as well as the more operational maritime patrol role, the Dornier 228 MPA has been ordered by the Government of Mauritius, the Republic of Maldives and, lately, the Royal Thai Navy.

The Indian Coast Guard have operated the Dornier 228 since 1986 from Daman on the western coast of the Indian peninsula and have recently accepted an additional batch of HAL-built aircraft to form a second squadron which will operate from Meenambakkam on the eastern coast of the country. The Indian Coast Guard have a total requirement for 36 Dornier 228s, all but the first three of which will have been produced by Hindustan Aeronautics Limited at Kanpur. The Indian Navy have also ordered a similarly-equipped batch of Dornier 228s (with the MEL Super Marec 360 degrees radar) for specialist patrol tasks and have requirements for a multi-role version in the near future.

Defence Budget 1990-91

In the budget presented to Parliament the allocation for defence is Rs 15,750 crore (approximately US $ 9.25 billion), an increase of 8.6 percent over the revised estimates of the previous year. Considering the inflation rate of plus seven per cent, the Defence Budget has increased only very marginally over the revised estimates of Rs 14,500 crores for 1989-90.

The Army has been allocated Rs 7,910 crore, an increase of 6.1 per cent over the previous year, the Navy Rs 877 crore (up 5.6 per cent), Air force Rs 2.017 crore (up 8.7 per cent). Ordnance factories Rs 143.20 crore (up 4.3 per cent), and capital outlay Rs 4.801.89 crore (up 13.5 per cent). Research and Development whose allocation was reduced by 3.7 per cent in 1989-90 has been given an increase of 22 per cent and put at Rs 777.4 crore including capital outlays.

Future MiG Production

According to press reports India and the Soviet Union have completed discussions on the continued production and upgradation of the MiG series of fighter aircraft and a protocol is likely to be signed shortly. Talks held between officials of Hindustan Aeronautics Limited (Nasik) and the Soviet Aviation Industry in February, focused primarily on the upgradation of MiG-27s, which fighter-type is presently assembled at HAL under licence from the Soviet Union.

One of the crucial decisions which was to be taken was licence-production of the MiG-29. A joint Indo-Soviet working group is to conduct a high level review of the two countries cooperation on defence, and the aviation protocol will be signed after conclusion of the working groups meetings.

First Flight Of LCA In 1995

"India is now poised to accelerate development of the Light Combat Aircraft (LCA)," stated the programme director Dr Kota Harinarayana at AGM of the Aeronautical Society of India. The LCA programme was launched in 1983 by the newly formed Aeronautical Development Agency (ADA), in response to a requirement by the Indian Air Force for light-weight fighter aircraft for the 1990s and in 1986 ADA had assembled a team of 300 engineers and scientists drawn from HAL, the Defence Research and Development Organisation and the National Aeronautical Laboratory (NAL) to work on the project.

The Government expects to have first flight of the LCA prototype by 1995 and commence series production three years later. In the Rajya Sabha session on 27 March the Minister of State for Defence, Dr Raja Ramanna said that milestone in the project included completion of the feasibility study in May 1985 followed by a contract with Dassault of France in 1988. The technology development phase is to begin in July 1990.

USSR offer Il-96-300 to India

The Soviet Union has recently offered their new commercial, three-hundred seater Il-96-300 to India for purchase, as well as for co-production. Extensive discussions on collaboration have been held between the Soviet Ministry of Aviation Industry and the Indian Government with Rupee term payments being among the several options discussed.

Audio-visual presentation and static-display of the Il-96-300 were made to the Indian officials. However the scheduled flying demonstration could not be carried out since the DGCA reportedly refused permission for an Indian test team to fly the "prototype" aircraft.

"India's Emerging Power" : Pentagon

The Pentagon's congressional presentation for security assistance programmes for the fiscal year 1991 acknowledges India as an emerging power with an influence far beyond the South Asian region. Under the section on the Pentagon's policy considerations towards India, the report states that since 1981, the US and India have increased "their high level dialogue and engaged in a more active relationship, particularly in the fields of commerce and high technology transfer, including dual use and military technology".

Tale Spin

Halt ! Identity ? Pass !

It can only happen in 'Incredible India' – and Aero India at that ! For over two decades, Air Force Station Yelahanka has hosted the biennial Air Show, organised by the Defence Exhibitions Organisation, which seeks to attract hundreds of exhibitors, most of them international, and so for a week every two years, the Indian Air Force allows tens of thousands of visitors to its otherwise highly secure precincts. The Show organisers hire private security firms for ensuring that visitors are properly badged however the outer perimeter is controlled by Karnataka Police while within the exhibition area, CISF personnel ensure that visitors do not cross the boundary.

Obviously, this private security agency at Aero India 2015 needed to be educated on whom to check at the gates. First, the Army Chief, in full regalia, was asked to queue up at the entrance which, as a good soldier, he did. Then the Air Chief, also in uniform and (under whom comes the entire IAF including AFS Yelahanka) had to undergo similar drill. He too was uncomplaining but there were plenty of red faces at the organiser's office.

Jai Hind !

From Hollywood to Bollywood

In his bid to explain the vast area under his command, US Pacific fleet commander Admiral Harry Harris, who was visiting India early March 2015, said his area of responsibility "extends from Hollywood to Bollywood and from polar bears to penguins". The Admiral of course was referring to the Pacific region where the US is planning to re-balance 60 per cent of its naval fleet by 2020.

But the description is gorgeous !

Isle of Calm

Leading Indian newspapers have recently carried large advertisements, offering 'peace and tranquility on an Island'. However, the location was tantalisingly anonymous for some time before its revelation as Diu, or 'Ilha de Calma' in Portuguese. Those who will consider investing in this tiny enclave on the southern coast of Saurashtra will probably find calmness but over half a century back, there were some fireworks indeed !

As Indian forces moved to evict the Portuguese from their last colonies on the sub-continent in December 1961, the garrison in Diu stubbornly held on till IAF Toofanis from Jamnagar made a devastatingly accurate rocket attack on the ATC tower, precipitating white flags.

It has remained an Ilha de Calma since then.

Water, Water everywhere !

Mankind may be dreading global water scarcity in the times ahead, but scientists have discovered water 'spouts' all over the solar system. An international team have evidence of hydrothermal vents on the Saturnian moon Enceladus, which would make this the only other place in our solar system to have this fountainhead of life.

Meanwhile, another team has reported "signs of another under-ice ocean, on Ganymede, the largest of Jupiter's moons. Scientists are already convinced that there is a large ocean, also covered by ice, on another Jovian moon, Europa. NASA's Galileo spacecraft had also found hints of hidden water on Ganymede and on another of Jupiter's moons, Callisto".

As a NASA planetary scientist has exclaimed, "its wonderful to find water, water everywhere".

Except on Earth?

Hungry, Kya ?

Over a period spanning the years 1978 – 1980, France's 'entertainer' Monsieur Mangetout (nee Michael Lotito) ate a Cessna 150. He did this in stages, breaking metal parts down into tiny pieces, and consuming plenty of water and mineral oil throughout the meal.

The conclusion : airplanes taste worse than airplane food !

Afterburner

GROB

Shinmaywa