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Cover: Airbus A380 under 'monsoon skies' at Farnborough 2016 (Photo: Airbus)

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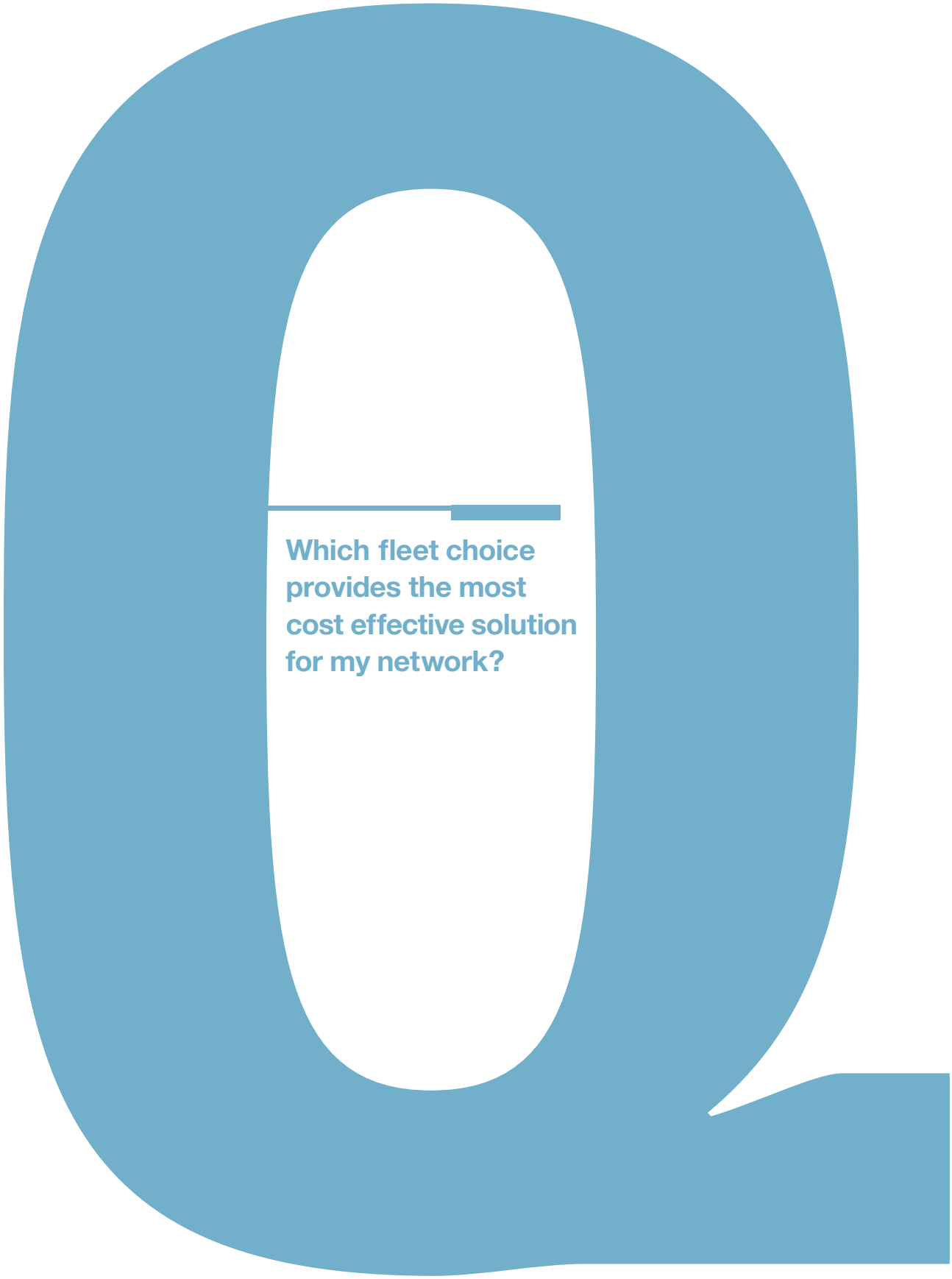

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Tejas at Last

The induction of two indigenous Tejas Light Combat Aircraft (LCA) into the Indian Air Force (IAF) in Bangalore brings a moment of celebration. It is after a gap of nearly five decades that the IAF has got an indigenously developed fighter aircraft. The HAL-made Marut HF-24 fighter was inducted into service in April 1967, fought in the 1971 war in the Rajasthan sector and was decommissioned from the IAF in 1983. It was around then that the proposal for an indigenous LCA went to the drawing board, which saw funds being released in 1993 and the first prototype was flown in 2001. As with any new product, there were teething problems with the Tejas and the IAF was not keen on inducting the HAL-made fighter into service. Then, Defence Minister Manohar Parrikar put his weight behind the project and helped overcome the resistance of the IAF and bring the project to fruition. The current plan is to have six squadrons of Tejas, of 20 fighters each, in service.

The concerns of the IAF were, however, not without merit. The LCA has limitations and cannot match the most modern fourth generation fighters various foreign suppliers have been offering to India. Moreover, the indigenous fighter has still not got the Final Operational Clearance (FOC), which signifies that the development of the aircraft up to agreed-upon specifications is complete. The first 20 Tejas fighters being inducted have only secured an Initial Operational Clearance (IOC) which means that they can undertake only limited operations. The IAF expects the next 20 to have the FOC, but there are worries about the next 80 fighters which are Tejas Mk1A, an improved version of the Tejas. Even a prototype Tejas Mk1A has not flown yet. As of now, only two fighters have been handed over to the IAF. HAL will have to ramp up its production capacity to 16 fighters per year to stick to the scheduled plan of induction. It will also have to produce the trainer version of the aircraft, a process likely to take some time.

It would be prudent to remember that according to the CAG, the indigenous component of Tejas is still 35 per cent. It has an American engine, and its radar and major weapon systems are also imported. India now aspires to indigenously make the Advanced Medium Combat Aircraft (AMCA). If AMCA is to avoid the convoluted path taken by the LCA, it will need stronger political handholding than that given to the LCA over the last 33 years. This will be essential to overcome the lack of coordination between various stakeholders which bedevilled the Tejas. Above all, India needs a more sophisticated technological base to successfully execute high technology projects. The achievement of inducting Tejas should not blind us to the fundamental challenges that still remain.

From *The Indian Express*

Obligations sans rights

India has joined the Missile Technology Control Regime or MTCR, an exclusive club of 34 countries that aims to prevent the proliferation of missile and unmanned aerial vehicle (UAV) technology. Understandably, there was much celebration over the signing ceremony held in New Delhi as the government said India becoming the 35th member of MTCR would be "mutually beneficial in the furtherance of international non-proliferation objectives". Coming as it did after the tough Chinese stance at Seoul that denied India a possible membership of the Nuclear Suppliers Group (NSG), India's ability to secure the endorsement of all member-countries of MTCR must have provided some comfort to Indian negotiators after the Seoul setback. MTCR is one of the four export control regimes, whose membership India has been seeking since it signed the civil nuclear agreement with the US in 2008. The other three such groups are: NSG, where the fate of India's membership at present is uncertain, the Australia Group and the Wassenaar Arrangement - all of which help regulate the conventional, nuclear, biological and chemicals weapons and technologies. There could be yet another reason for India's celebrations. China is not a member of MTCR. India could arguably use its membership clout to block China's application to be its member in the future. Whether this clout would be strong enough to get China to reconsider and withdraw its objections to India's membership of NSG is not yet clear, but some experts do not rule out such a possibility.

The larger question is whether India's membership of MTCR will help it trade more effectively in critical high-technology areas or whether it would allow access to technologies that are otherwise denied to it, eg, technology for missiles heavier than 500 kilograms and with a range longer than 300 kilometres. MTCR guidelines do not differentiate exports to member countries from those to non-member countries. They also do not entitle a member country to obtain technology from another or impose any obligation to supply it. What this means is that India's joining the MTCR will have little positive impact on domestic programmes for the development of missile or UAV technology, except where national laws of exporting countries like the US make distinction between members of MTCR and those who are not.

The MTCR arrangement is not a treaty that imposes legally binding obligations on its members except the one that prohibits dealing in technologies including those for missile systems capable of delivering a payload of more than 500 kg on a range of over 300 km. It is true that the membership will also now benefit India's space programme, making it easy for countries issuing export licences for missile systems below the prohibited categories since they would now be assured of India's overall compliance. But experts do point out that India has already developed technologies in areas that were so far denied to it under the MTCR. India's joining the various technology control regimes was a part of the commitment under its civil nuclear agreement with the US, which required it to accept technology transfer restraints. This is what India has done by becoming a member of the MTCR. But it should be noted that the membership does not and will not confer on it any additional rights.

From *Business Standard*

On the right trajectory

The sky is the limit goes the idiom. But for the Indian Space Research Organisation (ISRO), space is the limit, the organisation successfully launching into orbit 20 satellites, creating a record in the process. The launch was significant for it shows ISRO's

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prowess in space programmes and yet again showcases India as a destination for cost-effective satellite launch missions. Of the 20 satellites carried by the PSLV C-34 rocket, India's 725.5 kgs Cartosat-2 Earth observation satellite was the main payload. The other 19 consisted of two from educational institutions in India, 13 from the US, two from Canada and one each from German and Indonesia.

Twenty satellites is a big number but the record for launching the most number of satellites in a single launch is with Russia, which launched 37 satellites on its Dnepr rocket in 2014.

Foreign satellite launches are crucial for ISRO because the market is projected to run into billions of dollars by 2017. At the moment India sits on the margins because it has only the Polar Satellite Launch Vehicle (PSLV), which is primarily for low-weight satellites. The combined weight of the 20 satellites on Wednesday's launch was about 1,288 kg. ISRO's focus should be on Geo Synchronous Satellite Launch Vehicles (GSLVs), which can launch heavier satellites in the range of 5,000 kg. For cost-effective successful launches, ISRO needs to further perfect the cryogenic engine technology. Once that is achieved, India can compete with world leaders like the US or Europe.

Since the 1990s India has launched close to 80 satellites, of which more than 50 are foreign ones. If about 20 countries have signed up for launching from India (including the US), it is because launches here are close to 60% cheaper than in other countries . As India shifts from PSLVs to GSLVs with indigenous cryogenic engines — signs are that we will get there soon — ISRO will move into the prestigious club of heavy lifters. In that sense, this launch is a sign that India's space programme is on the right trajectory

From *The Hindustan Times*

Open Sesame India

NDA's decision to open up more space for foreign direct investment is timely and will benefit the economy. More importantly, as opportunities increase for foreign capital it will translate into jobs for young Indians. For India to realise the full potential of these policy changes, state governments have to play a complementary role. An encouraging environment for investments needs all levels of government to reduce the hassles which accompany creation of new businesses or expansion of existing ones. On this count, portents are promising as more and more states have become conscious of the need to scrap needless regulations.

FDI has been controlled through three instruments: equity caps, restricted entry and conditional clearances. Based on experience, NDA has tinkered with all three instruments to lower barriers for foreign investors. Now, 100% FDI is allowed in trading in food products manufactured or produced in India. India's farmers need to be freed from fetters imposed by middlemen. Adding a layer of competition will help. Infrastructure development is another area which should benefit as 100% FDI is automatically permitted even for existing airports. A tweak in guidelines has opened up the possibility of 100% foreign ownership of airlines, which should eventually add to competition.

Two other changes suggest that government is open to learning from experience. It has dropped a stringent condition that accompanied FDI in the defence sector. A condition which insisted on "state-of-art" technology has been replaced by "modern technology". It is a pragmatic move. The tougher the conditions, the less likely that India will see manufacturers starting production. In another move, tough local sourcing conditions have been diluted for companies having "state-of-art" or "cutting edge" technology. India's manufacturing ecosystem is not robust enough for government to set very tough conditions for FDI. It is best to get started before raising the bar at a later stage.

Enhancing FDI limits, by itself, is not adequate to get the massive investments India needs. Investment is attracted by the entire ecosystem, including the skill level of the workforce. The Narendra Modi government needs to take the initiative on reforms in labour and land, two critical factors of production. The educational sector, where a licence raj prevails, is also badly in need of reform. Unless the approach to economic reforms is comprehensive, missing pieces will limit the impact of individual changes. The good news is that recent developments in GST and FDI show India's political system has the appetite for reforms.

From *The Times of India*

Towards a safer coastline

A country with a 7,516-km coastline and 1,328 islands to guard cannot but feel vulnerable in these turbulent times beset by the nefarious activities of terrorists. And yet, for all the length of that coastline, India hardly qualifies as a nation of seafarers, save for poor fishermen who eke out a living from the sea. The importance of guarding the nation from marine vulnerability cannot be stressed enough, particularly since the 26/11 attackers came from the water. However, "the more the merrier" dictum does not always make sense.

The creation of a Central Marine Police Force to protect ports and institutions along the coast, like nuclear power plants, seems a very good idea, but the matter of coordination remains as the Navy, Coast Guard and the state marine police forces are already in this field. The vastness of the sea mandates first-rate navigation and surveillance equipment as well as supervision of landing points, besides "sail" power. Training is another key aspect for a country without great maritime traditions.

Towards this, the setting up of the National Marine Police Training Institute in Dwarka, Gujarat, and Marine Police Training centres in states and UT police training academies is crucial as high technology must be employed. It would be wise to prepare the manual for proper definition of jurisdiction, chain of command and coordination first. The states must be in a position to make best use of three Central forces besides strengthening the local police, which invariably is the first line of defence as intelligence flows from the grassroots and the sands of beaches.

From *Deccan Chronicle*

An all time low

Air Marshal Brijesh D Jayal writes on sanctity of the ASR

When the Agusta helicopter saga had hit news headlines earlier, this writer had concluded wistfully that if past performance was any indicator, the end would be predictable. A few reputations and careers of servicemen will be destroyed, the arms agents will move on to the next deal, and the real perpetrators and beneficiaries will live to enrich themselves another day. All that the nation will be left with are the service qualitative requirements with their sanctity open to abuse and the morale of the armed forces further eroded. Little did one realise that some of these reflections would soon come to haunt Indian governance, the institution of the Indian Air Force, its staff systems and processes.

The Italian high court judgment, whilst confirming that bribes had been paid by various officials of Agusta Westland, has given ample indication to where in India they were gratefully received. The involvement of the big fish gets conveniently camouflaged and diluted in partisan politics, but there is no such respite for those in uniform. Not surprisingly, the then Air Chief seems to have become the focus of media hype and, indeed, the target of the investigative agencies rather than being incidental to this entire episode, albeit with some accountability.

The scandal, in a nutshell, is this. The IAF air staff requirement for a helicopter for the Air HQ Communication Squadron, amongst other requirements, mandated a helicopter with minimum altitude ceiling of six kilometres. This made the Agusta helicopter ineligible. The one that was eligible was duly selected. The final stage of the process was halted at the initiative of the national security advisor in the National Democratic Alliance government for the ostensible reason of wanting to avoid a single vendor situation. To camouflage this interference, the logic of six kilometre maximum altitude and insufficient cabin door size were also questioned. Since the NSA does not feature anywhere in the chain of authority in the formal defence acquisition process, this impropriety was supposedly justified on the grounds of the prime minister's security requirements. The IAF was put on the defensive for not involving the Special Protection Group in the process of formulating ASRs. The stage was now conveniently set for interference by agencies outside of the defence acquisition process. Neither the IAF nor the ministry of defence gathered the moral courage to raise

objections. With a change to the United Progressive Alliance government, the new NSA pursued the same line.

In recent interviews, the then chief of air staff has made the following points. Successive NSAs insisted that the SPG be co-opted in amending the ASRs and that *pro forma* clearance was given to him which he took to be a decision of the government. He also opined that the users were the VVIPs and not the IAF. Whilst his voice of innocence regarding financial impropriety, unless proven otherwise by due process, needs to be respected, the IAF and MoD's meek acceptance of gross interference by NSAs and the SPG in meddling with the ASR process in violation of due MoD processes was an abdication of responsibility. As always, no one is asking questions of the MoD and the mandarins within for having conveniently gone missing in action at the time.

Having served intimately in the Plans Branch of Air HQ at four levels, from group captain to air marshal, this writer finds this gross interference in the IAF's ASR process to be in direct conflict with the principles that were the guiding light of the IAF's planning and procurement ethos. Whether or not these have undergone revision or whether moral flexibility has crept in is difficult to say. But a story of yesteryear when principles and institutions counted for more than pelf needs telling.

This writer moved from the field to the Plans Branch of Air HQ as joint director of Air Staff Requirements in 1977. At the time, one of the pending cases was an IAF proposal to replace the VIP Communication Squadron's obsolescent Tu-124 transport aircraft with a more contemporary alternative. This process had been stopped in its tracks by the new Janata government because complaints had been lodged with the Shah Commission of vested political interests pushing for the Boeing 737 during the Emergency. Then, on 4 November 1977, an IAF Communication Squadron Tu-124 jet carrying the prime minister, Morarji Desai and others crash-landed short of Jorhat airfield, killing the five air crew. Providentially, Desai and his entourage remained unharmed.

Somewhat shaken by the gravity of the near-miss to the prime minister's life, the government promptly ordered an immediate revival of the Tu-124 replacement process for which an ASR already existed. Even as the technical evaluation against the ASR was being conducted by this writer and his team, there were discreet messages from South Block that the Boeing 737 was politically sensitive and perhaps another contender whose name was hinted at would expedite the acquisition process. Mercifully, such missives were water off a duck's back in those benign times.

Our technical evaluation and recommendations were duly discussed at the level of DCAS and the CAS where the entire issue of discreet messages of contrary recommendations was also brought to the notice of the superiors. Once the CAS was satisfied at the professional logic of the IAF's recommendation, he drove to the defence secretary's office with this writer who was armed with the technical details of the proposal. A patient defence secretary reverentially heard all that the CAS had to share, including the indirect pressure that was being brought to bear. To his abiding credit, he told the CAS that he appreciated the professional conviction of the IAF and would support it to the hilt. The IAF had done its part and it was the MoD's responsibility to manage the political consequences. In hindsight, one can say today that it was the professionalism and high moral values of both these leaders, one military and the other of civil service, that ensured that the IAF Communication Squadron Boeing 737s have safely conducted operations for decades. Every professional in the chain understood their responsibility and acted with integrity. The nation triumphed over petty minds and greedy individuals.

The starting point of the induction of any major weapon system in the IAF is the formulation of the ASR, which is broad-based to ensure every relevant input. Since the final authority for effective operational use of the system rests only with the IAF, it is under its authority that the ASR is issued. Abdicating this responsibility to an outsider amounts to the betrayal of the principles of military command and control.

According to international aviation regulations, safety of the aircraft and every passenger on board is sole responsibility of the pilot once the aircraft begins to taxi out till it switches off. In the context of VVIP aircraft, the designated IAF user specialists are the Directorate of Transport and Helicopters and the Air HQ Communication Squadron. Both are intimately involved in formulation of the ASRs and are responsible to ensure safe and efficient conduct of air operations involving VIPs. With recent emphasis on security, these inputs also need consideration in the ASR-formulation process. But neither they, nor anyone, else can claim to take control of the ASR-formulation process. The final say is that of the IAF, which is entirely responsible for the safety of flight operations.

But there are issues of far deeper import that the nation must ponder beyond financial and other shenanigans that may well have been at play. These relate to the penetration of arms lobbies at the heart of the national security system. Amongst the thousands of documents that were shared by the Italian prosecutors in the present case were references to other Indian military programmes that the Italian company was interested in. Clearly, the armed forces headquarters and the MoD had been penetrated by interested arms lobbies.

There is a far more dangerous trend that seems to be rearing its head. The Milan court order shows that the Tyagi brothers knew well before SP Tyagi took over as CAS in December 2004 that the defence ministry would lower the altitude requirement for the helicopter, based on which payments to them had commenced in May 2004 itself. Since the then CAS was unwilling to compromise on altitude requirements, can it be assumed that this confidence stemmed from an advanced knowledge of IAF succession plans?

Appointments to the highest office in the armed forces have been the subject of lobbying and manipulation. It was not long ago that the topic came under media scrutiny when allegations were made of lines of succession being manipulated in the case of the army. Even at that time, the role of arms lobbies in influencing outcomes was mentioned. That bureaucratic and political lobbying by military aspirants is prevalent is hardly a secret. If there are whispers of the involvement of arms lobbies, then national security is now teetering on the edge. Is it too much to expect that parliamentarians and leaderships across the political divide would sense these dangers and act in unison? Or will they succumb to the temptation of scoring political brownie points to the detriment of national security? The nation awaits.

OPINION

Can India become an Arms Producer?

The recent policy announcement of a 100 percent limit in FDI in the defence sector is another turning point in India's quest for self-reliance in arms production. For long, the industry and the business sector in India and abroad have been demanding unlimited access to foreign investments in defence sector on the same lines as it exists in other sectors. Many aspects of the demand have been debated since the limit was raised to 49 percent last year. The new policy initiative, along with the not so old Defence Production Policy and Defence Procurement Procedures(DPP) should bring cheers to foreign companies willing to invest in India while retaining their management control. However, an unlimited FDI limit is just one of the many steps needed to convert the Government's initiative of 'Make in India' into a successful campaign and propel India's quest for self-reliance in arms and weapons production.

As India starts its tryst with higher category defence production with FDI in 'modern technology', it would be looking for technology transfer and production splurge at cheaper rates. Given the sensitiveness in the defence sector and huge development costs, it would be difficult to convince foreign companies for technology transfer to their Indian off-springs. Therefore, some policy initiative is also required towards an easy, accessible and flexible technology transfer policy. An added incentive could be an attractive defence exports policy wherein foreign companies are allowed to export unlimited portion of their weapons production. This is how the Chinese FDI policy worked successfully in the 'four modernisations'. Further, such a policy would create more jobs in the domestic market.

Critics might also vent their pessimism about the pace at which India can become a 'technology powerhouse'. Not long back, China was the largest arms importer of the world with a major share of its armoury coming from Russia and Israel. However, despite allegations of 'reverse-engineering' and technology thefts, the Chinese have managed to copycat a significant portion of foreign technology and today they are producing almost all of China's weapons requirement and even exporting it to many Afro Asian countries at dirt cheap rates. India needs to learn from the Chinese experience!

The quest for technological self-reliance also necessitates improvement in the DRDO's working. Despite consuming 6 percent of defence budget, there is little engendering of domestic technology in higher category. Equally dismal is the performance in patenting and marketing of in-house technology. The recommendations of the Rama Rao Committee need to be implemented in totality to push the DRDO on a constructive roadmap rather than allowing it to continue as a monolithic organisation producing technology already available off the shelf in the world.

Similarly, the defence PSUs and ordnance factories need overhauling for a meaningful contribution to the domestic Military Industrial Complex (MIC). So far, neither have they been able to feed the weapons requirement of the armed forces nor have theymade any significant exports despite a huge amount of cash flow and functional autonomy. They need to step up from monopoly to competition; from departmental mindset to corporate behaviour and overall from a liability on public finance to 'value for money'arrangement with the Government. The Kelkar Committee's recommendation of corporatisation of ordnance factories, if implemented, could have strengthened the domestic MIC. Since considerable amount of public money stands invested in them, the next set of policy reforms must propel them to 'perform or perish'.

It is also desirable to revamp the June 2014 industrial licensing policy in which many segments are excluded from the purview of foreign companies setting up production ventures in India. There is space for further rightsizing the list without any compromises on national security. A similar review is warranted for the offset policy where very little in-flow of cash has taken place despite streamlining the procedure and institutionalisation of Defence Offset Facilitation Agency (DOFA).

The international arms market is sluggish with few countries opting for high cost weapons import. India is not only an exception, but is also likely to remain the largest arms importer in the world for considerable period. Professional surveys by organisations such as KPMG has shown huge demand from Indian Government for weapons procurement. The survey findings seem to be correct since the Government of India has placed almost Rs 90,000 crore worth orders in last two years and plans to spend at least Rs 100,000 crore more in the near future. The new FDI policy would encourage many foreign companies to set up base in India since they would benefit from the 'buy Indian' category in the DPP and enable the country to make substantial savings on foreign exchange.

The new FDI policy supplemented with other above mentioned policy reforms, has the potential to create a simplified production environment like better bargaining leverage for Government, lesser cost of purchases, reduced influence of international trading factors like fluctuating rate of dollar and above all, lesser hassles of the previous syndrome (costlier and fluctuating supply of spare parts).

Bhartendu K Singh, CLAWS

The Aerospace Media Dinner

10th July 2016 – London

VAYU 4 Aerospace

Vayu flies high at international Aerospace Media Awards

India's oldest aerospace and defence journal, the *Vayu Aerospace and Defence Review,* now in its 42nd year of publication, once again provided stellar representation for India at the annual Aerospace Media Awards ceremony, held this year at the Farnborough Air Show (11-17 July 2016). Indeed, Vayu was the only Indian publication shortlisted for the prestigious awards, standing alongside global aviation and defence media leaders including *Flight International, Aviation Week, Defense News, and IHS Jane's* of the UK and USA.

Angad Singh receiving his award from Air Chief Marshal Sir Stephen Dalton, former Chief of the Air Staff of the Royal Air Force and President-elect of the Royal Aeronautical Society, with Liebherr Head of Corporate Communications Ute Braam and Guest Presenter Fred MacAulay

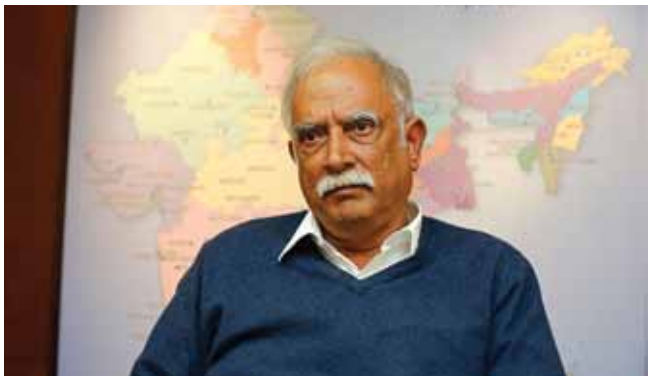
nominated for Media Awards

Vayu **was nominated in three categories for the 2016 awards. Professor Prodyut Das and Sayan Majumdar were listed for the prestigious 'Bill Gunston Technology Writer of the Year' award, for separate articles on the Indian AMCA and FGFA programmes respectively.**

Vayu's **Assistant Editor, Angad Singh, was awarded 'Best Young Journalist' for the year, the third time running that he has been nominated. In addition, his photo of an Indian Air Force Mi-17 firing rockets at night was shortlisted for the 'Best Aviation Image' award of the year.**

Peter Bradfield, Founder of the Aerospace Media Dinner, addresses the gathering

National Civil Aviation Policy 2016



The Ministry of Civil Aviation formally released the long-awaited National Civil Aviation Policy (NCAP) on 15 June 2016. The new policy is anticipated to be a turning point for the sector, attracting more investment, increasing capacity and lowering fares.

The controversial '5/20' rule, which prevented new Indian airlines from operating internationally until they had operated domestically for at least five years and had at least 20 aircraft in their fleet, has been revised to a '0/20' rule, which eliminates the time criterion, leaving only fleet size as a condition to international operators. Airlines will still be required to deploy at least 20 per cent of their capacity on domestic routes. Coupled with a more investment-friendly policy in general, including up to 100% FDI from non-airline investors, the move has been welcomed by the industry.

P Ashok Gajapathi Raju, Minister of Civil Aviation (*in photo above*), stated that as the "first ever integrated National Civil Aviation Policy," the new document would be "a game-changer for the sector." The Minister noted that the main objectives of the NCAP were "to make flying affordable, safe and convenient, and to promote balanced regional growth, tourism, infrastructure, and ease of doing business."

A key focus area of the NCAP is regional connectivity and the implementation of a Regional Connectivity Scheme (RCS) to revive

un-serviced airports at so-called tier II and III cities in India. The policy proposes that airfares on RCS routes for one-hour flights will be capped to Rs 2,500. Earlier this year, the Government had raised excise duty on Aviation Turbine Fuel (ATF) from 8 per cent to 14 per cent, but exempted ATF at airports that fall under the RCS.

The NCAP is also looking at enhancing skill development in the aviation sector, and leveraging existing human resources. Ministry officials noted the large numbers of Commercial Pilot Licence (CPL) holders in the country that remain unemployed and without aircraft type certificates that would accelerate their integration into the workforce. The new policy will attempt "to ensure the availability of 3.3 lakh certified skilled personnel by 2025," according to the Minister.

Broadly, the key goals of the new policy are for India to become the third largest civil aviation market by 2022 (from ninth largest presently), for domestic ticketing to grow from 80 million in 2015 to 300 million by 2022, to increase the number of airports with scheduled commercial flights from 77 in 2016 to 127 by 2019, to boost cargo traffic by a factor of 4, to 10 million tonnes, by 2027, to ensure growth of regional aviation under the Regional Connectivity Scheme, institute flexible and liberalised 'open skies' and codeshare agreements, incentivise the MRO sector to develop as hub for South Asia, enhance skill development in the sector, develop new greenfield airports and heliports, and facilitate ease of doing business through deregulation, simplified procedures and e-governance.

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Contract for 36 Rafales "near finalisation"

"Negotiations between Indian and French teams regarding the final terms of the contract are now concluded," stated Defence Minister Manohar Parrikar on 17 June 2016 in Bangalore. "I should receive their report this week and the Ministry will analyse it and then send it to the Government," he said. "After the report is submitted, it may take the government four to five weeks to officially come to a conclusion as to the final terms of the contract." A month later, in mid-July, the defence minister was quoted as directing the DAC to submit its report (on the Rafale acquisition) "expeditiously".

Mr Parrikar had earlier also indicated that the Government of India would look to acquire new single-engine and twin-engine fighter types under the Government's 'Make-in-India' initiative for manufacture in India. "Final discussions are likely to be concluded in a couple of months to decide the exact course of action, though more or less the line is decided."

Extensive negotiations have reportedly been underway between the Ministry of Defence and the Air Force to decide on final requirements and iron out financial aspects of such a proposal. The plans for production of a twin-engined fighter in India could tie-in with recent remarks by Dassault Aviation chief executive Eric Trappier: "At the moment we are negotiating the price for the first 36 … we are already preparing the second phase of the contract, that is an additional order of some 90 aircraft but that is in the long term." At the same time, Saab has been running a highly visible campaign in India to promote the Gripen E to be built in India, while Lockheed Martin has offered its F-16V and Boeing has proposed the F/A-18 E/F Super Hornet for manufacture in India.

Safran offers joint development of Kaveri

According to reports from France, and as possible part of offsets arising from the Rafale contract, Safran has offered to invest in further developing the GTRE-Kaveri engine, initially intended for the light combat aircraft. Several rounds of discussions have taken place between Safran, which has developed the M88 engine for the Rafale, and the DRDO for upgrading the Kaveri as power plant for the Tejas LCA Mk1A. Meanwhile, GTRE are understood to be developing a scaled-down version of the Kaveri for India's UCAV programme (referred to as 'Ghatak'), being developed between the GTRE and ADA.

Tejas LCA joins the IAF

On 1 July 2016 the IAF formally established its first HAL Tejas-equipped unit, No. 45 Squadron 'Flying Daggers,' which will initially be based at HAL Bangalore for two years, before moving to Air Force Station, Sulur (Coimbatore). The Squadron was commissioned in a relatively low-key ceremony held at the ASTE technical area at HAL Bangalore airport, with Air Marshal Jasbir Singh Walia, AOC-in-C Southern Air Command as Chief Guest. The ceremony had two Series Production fighters (SP-1/LA-5001 and SP-2/LA-5002) formally inducted into the Squadron. Gp Capt Madhav Rangachari, a Tejas test pilot with operational experience on MiG-21s and Mirage 2000s, is first CO of No. 45 Squadron with the Tejas LCA, which had been number plated in 2002, when flying MiG-21Ms.

Indian CAS flies Gripen in Sweden

In what is regarded as a unique statement, Air Chief Marshal Arup Raha, Chief of the Air Staff Indian Air Force made a flight in the Saab Gripen fighter at the Company's facility at Linköping in Sweden, on 9 June 2016. He flew a twin-seat Gripen D aircraft with Wing Commander (Flying) Michael Lundquist, the photograph above taken after his landing, by Captain John Lidman, of F7 Wing at Såtenäs. Even more interestingly, his AA Air Commodore Pankaj Sinha was also in another Gripen D, the two fighters flying in formation before landing.

The Indian CAS was on a five-day tour of Sweden from 7 June, following discussions on cooperation in aerospace and defence between the two countries as initiated by Indian Prime Minister

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Narendra Modi and Swedish Prime Minister Stefan Löfven during the 'Make in India' summit in Mumbai in February 2016.

Sweden and Saab have offered the Gripen for production under Prime Minster Modi's 'Make in India' programme, and it is understood that Swedish State Secretary for Defence, Jan Salestrand, presented a formal offer to Indian Defence Minister Manohar Parrikar during the Shangri La Dialogue in Singapore. Saab is planning to establish production of the Gripen multirole fighter in India and establish a long-term relationship for future programmes including comprehensive transfers of technology and joint development of future fighters (AMCA).

First Su-30MKI with BrahMos

Maiden flight of a Su-30MKI with an inert BrahMos missile was successfully carried out at HAL Airport, Nasik on 25 June, the aircraft flown by Wg Cdr Prashant Nair and Wg Cdr MS Raju, both flight test crew with the Aircraft and Systems Testing Establishment (ASTE). HAL's CMD stated that the BrahMos integration project was executed by HAL as an indigenous effort, without assistance of the aircraft OEM for the required modifications. HAL signed a contract with BrahMos Aerospace Private Limited (BAPL) in 2014 for delivery of two Su-30MKIs, modified to be capable of carrying a BrahMos cruise missile. The first modified aircraft was airborne in one year, with the second aircraft following a year later. BAPL CEO and MD Sudhir Kumar Mishra said this was "the first time in the world that such a heavy (2,500 kg) supersonic cruise missile has been integrated on fighter aircraft."

Around 40 Su-30MKI aircraft are expected to be modified to be BrahMos-capable, while the test programme will involve an extensive flight testing campaign, covering further captive carriage trials, separation tests, and a range of firing trials.

India increases defence cooperation with Vietnam

Countering China's "growing military assertiveness in the region," the government of India is considering selling supersonic BrahMos cruise missiles to Vietnam, this also figuring in the bilateral talks between Defence Minister Manohar Parrikar and his Vietnamese counterpart General Ngo Xuan Lich in June 2016.

It is reported that India will also increase its military presence in Vietnam by expanding an existing programme to upgrade Soviet-era military equipment used by the Vietnamese military. Major areas identified for working together include upgrade of Soviet systems, including thermal sights and fire control systems for T-54 and T-55 AFVs, and upgrade of Mi-17/Mi-8 helicopters. India has both military and technical experience with these assets, and in the past has supplied spare parts to Vietnam for its Soviet-origin warships, overhauled MiG-21 fighters, and has trained Vietnamese

Naval personnel to operate Russian *Kilo*-class submarines. India has already extended a $100 million credit line to Vietnam, which is being utilised for procurement of L&T offshore patrol vessels for its Border Guard.

India and US discuss new cooperation on defence

US Secretary of Defence Ashton Carter met with Indian Defence Minister Manohar Parrikar at the annual Shangri-La Dialogue in Singapore to "identify new ways to cooperate" on defence. "The US-India military relationship", Carter said, "is as close as it has ever been. Through our strategic handshake—with the United States reaching west in its rebalance, and India reaching east in Prime Minister Modi's Act East policy—our two nations are exercising

together by air, land, and sea. And there's also a technological handshake: we're moving toward deeper and more diverse defence co-development and co-production, including on aircraft carrier design and construction."

LEMOA to boost US-India defence ties

The text of the Logistics Exchange Memorandum Of Agreement (LEMOA) — which will allow US warships and aircraft to be refuelled and repaired in India — was finalised during PM Narendra Modi's visit to Washington DC on 7-8 June 2016. Furthermore, the US now recognises India as "major defence partner" and has supported India's successful entry into the Missile Technology Control Regime (MTCR). LEMOA covers four key areas: training, exercises, port calls and humanitarian assistance. Both countries will have to seek prior permission for facilities and the agreement will not entail any permanent bases for the US in India. LEMOA will assist India as it expands its naval outreach.

The US has a string of bases in East Africa, Persian Gulf, Diego Garcia (Indian Ocean), Philippines, Japan, Australia and Japan. Indian warships and aircraft can seek similar refuel and repair facilities at these bases on long deployments, which are becoming increasingly more frequent. A formal signing of LEMOA will take place once the pact is approved by the Cabinet Committee on Security (CCS).

Three new MoD committees for radical reform

India's Ministry of Defence has convened a set of independent committees, whose recommendations will provide the bases for radical reform. One is charged with reshaping defence spending, another with reforming procurement by restructuring the MoD's acquisitions branch, with no less than five sub-committees to facilitate private sector inclusion in the defence sector.

The first committee, a 12-member panel headed by retired Lt Gen DB Shekatkar, will recommend measures to rebalance defence allocations between revenue and capital expenditure, looking at ways to cut down manpower without reducing the military's combat capability.

The second committee has been constituted under former Petroleum Secretary Vivek Rae, to study "the setting up of a Defence Procurement Organisation in the Government of India." The committee is required to suggest the functional mandate of the proposed procurement body, its organisation and staffing, and to suggest how autonomously it could function.

A further group of sub-committees was constituted on May 24 to salvage the 'Strategic Partners' (SP) model for private sector participation in the 'Make in India' initiative, as recommended by the Dhirendra Singh committee and VK Aatre Task Force earlier this year.

First official flight of HTT-40

On 17 June 2016, Defence Minister Manohar Parrikar witnessed first official flight of the indigenous HTT-40 Basic Trainer Aircraft designed and developed by HAL at Bangalore. The aircraft was flown by Gp Capt C Subramaniam and Gp Capt Venugopal. The HTT-40's maiden flight, however, had been on 31 May 2016, lasting 30 minutes.

The Defence Minister congratulated HAL, saying that "the young team has taken a calculated risk and have flown the aircraft within one year and kept their assurance. The indigenous content on HTT-40 is close to 80%. Almost 50% of the components of HTT-40 are manufactured by private players of the Indian aerospace ecosystem. Here, the role of private players and MSMEs has been significant in the production of parts. The IAF is positive on all these developments."

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Defence Minister Manohar Parrikar gives the thumbs up after being briefed on the HTT-40 cockpit systems by Prashant Bhadoria, Chief Designer of the aircraft

According to T Suvarna Raju, CMD HAL, "The project will now go in full throttle as we aim to get the aircraft certified in 2018. Towards this, HAL will be manufacturing three prototypes and two static test specimens."

HAL began detailed design activities of the HTT-40 in August 2013, allotting internal resources. The detailed design phase was completed in May 2015 and from there it has taken only one year to fly the first prototype. The HTT-40 will supplement the Pilatus PC-7 Mk II in the basic training role to meet current training requirements of the Indian Air Force but will have provisions for weapons carriage to expand the role.

First women fighter pilots with IAF

The Indian Air Force commissioned its first women fighter pilots on 18 June 2016, at the Combined Graduation Parade at Air Force Academy, Dundigal. The three pilots are Flying Officers Avani Chaturvedi, Bhawana Kanth and Mohana Singh (*see picture*). A total of 130 Flight Cadets including 22 women trainees were commissioned as Flying Officers at the Combined Graduation Parade, Flying Officer Adarsh Hooda being awarded President's Plaque and the Chief of the Air Staff 'Sword of Honour' for standing first in Overall Merit in the Pilot Course. Flying Officer Narendra Kushwaha and Flying Officer Sahil Yadav were awarded the President's Plaque for being first in overall merit in Navigation and Ground Duty branches respectively.

Boeing and Mahindra DS establish C-17 Training Centre

On 8 July 2016, Boeing and Mahindra Defence Systems formally established a centre in Gurgaon to provide C-17 training services to the Indian Air Force, with Air Marshal BS Dhanoa, VCAS, present on the occasion. Once fully operational, the new centre will be capable of conducting local and multi-site simulations for added realism and more robust training.

"The centre, in partnership with Mahindra Defence, is another example of the steps we are taking to contribute to the building of a holistic aerospace ecosystem in support of Make in India," said Pratyush Kumar, President, Boeing India. The C-17 training facility, which is located at the Flight Simulation Technique Centre in Gurgaon, will be a full-service location offering instruction to aircrews that operate the 10 C-17 airlifters that Boeing delivered to the IAF in 2014.

Tri-Services Commanders' Conference

The Tri-Services Commanders' Conference of the southern region took place at Jodhpur 7-8 July 2016, involving seven Commanders of the Southern Command of the Indian Army, Western Naval Command, Eastern Naval Command and Southern Naval Command of Indian Navy, South Western Air Command and Southern Air Command of the Indian Air Force plus the Andaman and Nicobar Command, a Tri-Service Command.

Hosted by AOC-in-C SWAC, Air Marshal RK Dhir, the objective was "to strengthen and promote jointness amongst the three services." The concept of operations in a network centric warfare scenario and exploitation of newly inducted weapon systems for enhancing operational capability in a synergised tri-service environment was focus of the conference.

India joins MTCR

On 27 June 2016, India was formally admitted into the Missile Technology Control Regime (MTCR), as its thirty-fifth member, which "would be mutually beneficial to the furtherance

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of international non-proliferation objectives," according to a Government statement.

The regime works to limit access to sophisticated missile and missile-related technologies, with particular focus on systems capable of carrying a payload of at least 500 kilograms to a distance of at least 300 kilometres, a definition that includes both cruise missiles and larger drones. This limit constrained the capabilities of the Indo-Russian BrahMos missile (developed while Russia was an MTCR member and India was not) and restricted Indian access to long-range UAVs with greater capabilities than those currently in service. However, while the MTCR is in fact a technology denial regime, there are precedents for missile and drone sales among member nations and India certainly hopes to capitalise on these.

MR-SAM in successful double test

A Medium Range Surface-to-Air Missile (MR-SAM) was successfully test-fired on 30 June from the Integrated Test Range off the Odisha Coast, hitting a pilotless target aircraft. A second missile was then test-fired later in the same day, engaging and destroying a target in a different (low altitude) envelope, which demonstrated two key capabilities of this system.

The MR-SAM, jointly developed by the DRDO and Israel Aerospace Industries (IAI), is known as Barak-8 in Israeli service and LR-SAM in Indian Navy service. The test launches were conducted by a team comprising both Indian and Israeli personnel. The programme also involves a number of Indian public and private sector firms, including Bharat Electronics, Larsen & Toubro, Bharat Dynamics, and the Tata group.

ISRO launches record 20 satellites in a single flight

On 22 June, the Indian Space Research Organisation launched a PSLV-XL rocket carrying a payload of 20 satellites, including two from Indian Universities and 17 of foreign origin, into Sun-Synchronous Orbit (SSO). PSLV flight C-34 lifted off from the Satish Dhawan Space Centre and 16 minutes later placed its primary payload, an ISRO Cartosat-2C Earth observation satellite into its designated orbit. Over the next 10 minutes, the remaining satellites were placed in their intended orbits.

Besides putting 20 satellites into orbit, the PSLV rocket itself performed two propulsion experiments after its primary mission was complete. 50 minutes after deploying the satellites, the fourth stage rocket engine was re-ignited for five seconds, then shut down for another 50 minutes and re-ignited again for another five seconds. The manoeuvres are intended to develop the capability to put multiple satellites into different orbits in the same mission.

India and Iran to develop strategic Chabahar port

During his May 2016 visit to Iran, Prime Minister Narendra Modi announced that India would build and operate the key port of Chahbahar, India investing $500m to develop the strategically important port, close to Iran's border with Pakistan. The port would open a transit route to Afghanistan and Central Asia for Indian goods and products, avoiding the land route through Pakistan. India also intends to bring gas from Central Asia to the port and then transport it to India.

"The bilateral agreement to develop the Chabahar port and related infrastructure, and availability of about $500m from India for this purpose, is an important milestone. This major effort would boost economic growth in the region," stated PM Modi, while Iranian President Hassan Rouhani welcomed India's investment, saying, "Considering all the credit lines that are going to come from India into the Chabahar port, it can very well turn into a very big symbol of cooperation between the two great countries of Iran and India."

Indian Navy expands bases in Island Territories

The Indian Navy is expanding its presence in island territories on both the western and eastern seaboards to ensure protection of national interests in the rapidly-militarising Indian Ocean Region (IOR). After a Naval Detachment (NavDet) was commissioned at Androth Island of Lakshadweep in May 2016, the government has now accorded sanction for 2.18 acres of land for another such NavDet on Bitra Island in the same archipelago.

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The broader plan to bolster maritime and coastal security includes setting up of forward-operating bases (FOBs) at Tuticorin (Tamil Nadu) and Paradip (Odisha), smaller operational turnaround (OTR) bases at Kamorta, Campbell Bay, Shibpur and Diglipur in the Andaman and Nicobar Islands, and NavDets at Bitra and Minicoy in Lakshadweep *(photo above of Agatti airstrip in the Lakshadweep)*. There is also a plan to boost force-levels and infrastructure at the strategically located Andaman and Nicobar Command (ANC), to counter China's strategic moves in the IOR as well as ensure security of sea lanes converging towards the Malacca Strait. Implementation of the coastal surveillance network is also underway, with 36 radar stations coming up on the mainland, six in Lakshadweep, and four in the Andaman and Nicobar chain. Phase-II will see radar stations installed at another 38 sites, along with induction of an additional eight mobile systems.

Competition for Indian Navy's NUH requirement

Tata Advanced Systems Limited (TASL) is partnering with Bell Helicopter (a Textron company) to compete for the Naval Utility Helicopter (NUH) requirement of the Indian Navy, which could be upto 100 numbers. Tatas are to form a joint venture with Bell to bid for the 'Make in India' contract under existing Foreign Direct Investment (FDI) norms, and will assemble Bell 429 helicopters (*photo below*) in India if awarded the contract.

The procurement programme will see Indian companies serve as lead bidders, partnering with foreign OEMs for technology. Airbus Helicopters are reportedly also competing, in partnership with Mahindra, to supply the AS 565 Panther naval helicopter (*photo above*). The Indian Navy presently operates a range of ageing and obsolescent helicopter types, essential the HAL Chetak and helicopter modernisation to keep pace with warship construction is becoming a key priority

AoN for missile vessels and Jaguar simulators

The DAC has granted an Acceptance of Necessity (AoN) for six new missile vessels to replace the current *Veer*-class corvettes, at an estimated cost of Rs. 13,600 crore. A Rs 86-crore project for modernisation and augmentation of naval shipyard facilities was cleared along with acquisition of five indigenous diving support vessels worth Rs 150 crore. Procurement of indigenous simulators for IAF Jaguar strike fighters, worth Rs 500 crore, and establishment of an electronic warfare range by Bharat Electronics Limited (BEL), at a cost of Rs. 1,330 crore, were also approved.

Exercise *Malabar 2016*

In consonance with India's 'Act East Policy' and growing relations with the USA and Japan, Indian Navy ships participated in the 20th edition of Exercise *Malabar 2016* with the US Navy and Japanese Maritime Self Defence Force (JMSDF). The IN and USN have regularly conducted the bilateral *Malabar* exercise since 1992. Since 2007, *Malabar* has been held alternately off India and in the Western Pacific. The 19th edition of the exercise was conducted off Chennai and included participation by the JMSDF (*see Vayu VI/2015*).

This year's edition was carried out from 10 to 17 June 2016, with the harbour phase at Sasebo, Japan from 10 to 13 June and the sea phase in the Pacific Ocean from 14 to 17 June. The primary aim of the exercise was to increase interoperability among the three Navies and develop a common understanding of procedures for Maritime Security Operations. The IN deployed ships from the Eastern Fleet for the exercise, these being indigenous *Shivalik*-class stealth frigates INS *Sahyadri* and INS *Satpura*, fleet tanker INS *Shakti*, and indigenous missile corvette INS *Kirch*. The ships embarked one Sea King Mk.42B ASW helicopter and two Chetak utility helicopters between them. The Indian flotilla also made

various port calls at a number of friendly nations during their two-month deployment, stopping at Cam Rahn Bay (Vietnam), Subic Bay (Philippines), Busan (South Korea), Vladivostok (Russia) and Port Klang (Malaysia).

The US Navy was represented by ships from the 7th Fleet based at Yokosuka, Japan, including the aircraft carrier USS *John C Stennis* (CVN-74) and its embarked Carrier Air Wing 9 (CVW-9), along with *Ticonderoga*-class cruiser USS *Mobile Bay* and *Arleigh Burke*-class destroyers USS *Stockdale* and USS *Chung Hoon*, all with embarked helicopters. In addition, one *Los Angeles*-class nuclear fast attack submarine and P-8A Poseidon Long Range Maritime Patrol (LRMP) aircraft from VP-8 'Fighting Tigers' also participated.

The JMSDF was represented by JS *Hyuga*, a helicopter carrier with Sikorsky SH-60K ASW helicopters along with Lockheed P-3C Orion and Kawaski P-1 LRMP aircraft, plus other warships for specific parts of the exercise. Special Forces of the three Navies also interacted during the exercise.

ICG-KCG Exercise *Sahyog-Hyeoblyeog* 2016

A Coast Guard delegation from the Republic of Korea, led by Commissioner General Hong Ik-Tae visited India from 8-11 June 2016, in connection with joint exercise with the Indian Coast Guard (ICG), the Indian delegation headed by DG Rajendra Singh, PTM, TM, Director General Indian Coast Guard. This was followed by a joint ICG-KCG exercise called *Sahyog-Hyeobleog* off Chennai on 10 June 2016, which included maritime SAR, anti-piracy and various other operational activities, which were witnessed by the KCG Commissioner General and DG Indian Coast Guard. Korea Coast Guard Ship 3009, a 3,000-tonne *Taepyungyang*-class vessel, was the sole KCG participant, while the ICG provided a range of ships and aircraft for the exercise.

Thyssenkrupp Marine Systems to integrate Harpoons

On 29 June, Thyssenkrupp Marine Systems signed a key contract worth €35 million (approximately Rs 250 crore) for the upgrade of two Indian Navy *Shishumar*-class (HDW Type 209) submarines to fire Boeing UGM-84 Harpoon missiles. The retrofit of the new weapon suite will be carried out at Naval Dockyard, Mumbai and the contract includes a training package to support and operate the system.

Commenting on the contract, Dr Gurnad Sodhi, Managing Director of Thyssenkrupp Marine Systems' in India said, "We are happy to take on this project to now integrate the Harpoon missiles in two of the four submarines" and emphasised the firm's willingness to integrate other weapons with newer submarines, including BrahMos with the Type 214 SSK for the long-delayed P-75(I) submarine programme.

Coast Guard to acquire 30 new helicopters

To boost its surveillance and search and rescue capabilities, the Indian Coast Guard has proposed to induct 30 more helicopters into service by 2020. The expansion plan will see the ICG acquire 16 Dhruv advanced light helicopters (ALH) from HAL and 14 other twin-engined helicopters from abroad. The latter proposal has been pending with the MoD for some time with several options under consideration.

GoAir inducts A320neo, "can go international"

Budget carrier GoAir has received its first Airbus A320neo airliner, thus becoming eligible for international operations, as this is the 20th aircraft in the airline's fleet. GoAir is the second operator in India to have inducted the new A320 variant, after IndiGo. With an 8.5 per cent market share in domestic traffic, GoAir plans to induct eight A320neo aircraft in the fleet by March 2017. The airline has ordered 72 new A320neo aircraft, valued at about Rs 32,400 crore. The A320neo incorporates new generation engines and large wing-tip devices ('sharklets'), which together allow for increased fuel savings and reduced CO2 emissions. GoAir is also the first airline to use this aircraft in the Spaceflex configuration, with 186 seats and galley and lavatories located at the rear of the aircraft.

GoAir doubles A320neo order

India's fast growing low cost airline GoAir has signed a Memorandum of Understanding (MoU) for 72 A320neo aircraft during the Farnborough International Airshow. GoAir, a Wadia Group company, announced this latest order following a similar agreement for 72 A320neo placed in 2011 bringing the total order book to 144 aircraft. The first two aircraft from this order were delivered in June. With the NEO induction, GoAir will expand its network and offer fliers better connectivity and continue its growth as one of India's preferred low-cost airline.

"The new aircraft will help us in unlocking new domestic routes while providing a springboard for continued international network expansion in the years to come," said GoAir CEO Wolfgang Prock-Schauer *(seen in the picture with John Leahy, Airbus Chief Operating Officer – Customers)*.

"Demand for 1,850 new airliners in India"

Boeing has forecast a demand for 1,850 new airliners in India, valued at $265 billion, over the next 20 years, according to the company's annual Current Market Outlook (CMO) for India. "India continues to have a strong commercial aerospace market and the highest domestic traffic growth in the world," said Dinesh Keskar, senior vice president, Asia Pacific and India Sales, Boeing Commercial Airplanes (*see above*). "With the new aviation policies in place, we see even greater opportunities and remain confident in the market and the airlines in India."

According to Boeing's CMO, single-aisle airliners such as the Next-Generation 737 and 737 MAX will continue to account for the largest share of new deliveries, with airlines in India needing approximately 1,560 aircraft. These new airliners will continue to support the growth of low-cost carriers and replace older, less-efficient airliners.

Scoot in India

Singapore Airlines has expanded operations to India with its low cost airline Scoot flying to new destinations and increasing the frequency of its current schedules. The parent Singapore Airlines is using its no-frills (Scoot and Tigerair) and premium carriers (Singapore Airlines and Silkair) to reach out to fliers in the low to premium segments with an identity that merges seamlessly across its brands. The last in a chain of four brands that SIA introduced in the country, Scoot currently flies Singapore-Chennai and Singapore-Amritsar and plans to add Jaipur to the list by October this year.

Scoot is aiming for the budget platform, currently being served by a number of domestic and international carriers. In doing so, Scoot hopes to leverage SIA's long-standing association with India and the strong recall the brand has among fliers across categories. And at the same time it is giving wing to its parent's ambitions to be the largest international airline across segments, in India.

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"No one will buy Air India!"

In a surprisingly frank statement, Union Civil Aviation Minister Ashok Gajapathi Raju stated that Air India's "books are so bad" that nobody would buy the troubled state-owned airline, even if the government did want to sell it off. Ruling out disinvestment in the carrier, which has a debt of Rs 50,000 crore, Raju at the same time said that taxpayers' money could not be committed "for eternity."

Grappling with mounting debts and tough business conditions, Air India has been in the red since the merger of then Air India and Indian Airlines in 2007 and is presently "surviving" on a Rs 30,000 crore government bailout package extended by the government.

However, while there has been no official announcement, the airline has managed to eke out an operational profit of Rs 6-8 crore in the 2015-16 financial year, prompting Civil Aviation Secretary RN Choubey to say, "Air India plans to expand its fleet from 130 aircraft to 230 aircraft in the next four years....The airline now expects to see net profit in 2018-19 financial year, two years ahead of the timeline fixed in the turnaround plan." Air India's total loss is projected to have gone down by almost 60% to Rs 2,636 crore in the 2015-16 financial year, compared to a Rs 5,859.91 crore loss in 2014-15.

Airbus to establish training centre in NCR

Airbus is establishing a pilot and maintenance training centre in the National Capital Region of Delhi, to support the county's need for increasing numbers of new Airbus pilots. According to Airbus' latest global market forecast, India will induct over 1,600 passenger and freighter aircraft in the next 20 years, with a commensurate demand for new pilots and maintenance engineers. This investment in a training centre is a key strategic Airbus initiative in line with the country's 'Skill India' programme launched in 2015 by the Indian Government to develop a wide range of advanced competencies. "Airbus is committed to offering the best-in-class training skills comparable anywhere worldwide."

The centre will be fully owned by Airbus Group India with training to be delivered by Airbus' specialised training instructors. The centre will be built in a modular concept in order to accommodate four A320 full-flight simulators, with potential for further expansion. Airbus has been providing maintenance training from its existing centre in Bangalore since 2007, and has so far trained over 2,750 maintenance engineers. The new centre will accelerate the pace of training to help match the A320neo deliveries to India. Staffed by Airbus trainers, the new pilot training centre will have the capacity to train over 8,000 pilots and 2,000 maintenance engineers over 10 years from 2018 onwards.

Air India to induct 21 A320neos

Air India and Aviation Lease and Finance Company (Alafco) have signed a lease agreement for operating lease of 14 CFM-powered A320neo aircraft, "benefiting from the A320neo's 15 per cent fuel burn reduction, reduced noise and environmental footprint, while offering its passengers best in class comfort." The aircraft will be delivered from early-2017. Presently, Air India operates 66 A320 family aircraft including 22 A319, 24 A320 and 20 A321. In addition, Air India plans to lease seven more A320neos for up to 12 years, with the aircraft planned to enter service before July 2018.

Revival of 50 "no-frills" Indian airports

Amongst various plans announced by the Ministry of Civil Aviation, its Secretary Rajiv Nayan Choubey has stated that the government "has firmed plans to revive 50 low-cost or no-frills

airports across the country in the next three years. Airlines operating from these airports will get concessions on landing, parking charges and other expenses. Location of these airports are being finalised after consultations with the airlines to ensure commercial viability."

The Regional Connectivity Scheme (RCS) in the new aviation policy has proposed to cap fares at Rs 2,500 for a one-hour flight, and proposes a 2 per cent levy on all domestic and international flights on metro routes to support regional connectivity. The government will also exempt service tax on tickets on RCS routes, and remove excise duty on aviation turbine fuel drawn by airlines on these routes.

Simla reconnected by air

After a gap of nearly four years, the capital of Himachal Pradesh has been connected by air. Simla's airport at Jubbarhatti, located 2,196 metres above sea level, had not received scheduled flights since 6 September 2012, "affecting tourist and business travel to the state." It will be recalled that services to Simla began in the late 1980s with state-owned Vayudoot operating HAL-built Dornier 228s, this twin-engined commuter aircraft having 19 seats. Vayudoot was incorporated into Indian Airlines a decade later before the domestic carrier itself was merged with Air India and the new (joint) airline phased out all smaller turboprops from its fleet.

A private airline, Air Himalayas, operating a Cessna Grand Caravan of just 9 seats, have now re-commenced flights from Delhi to Simla along with Chandigarh-Simla and Chandigarh-Kullu air links. State Urban Development Minister Sudhir Sharma also flagged off the first flight from Simla to Gaggal (near Dharamsala).

Juhu airstrip to be extended

With Mumbai's international airport "close to saturation", the government wants immediate action on a plan to extend the Juhu airport runway by 650 metres, jutting into the sea, to ease congestion at the Santa Cruz International Airport.

"The redevelopment of the Juhu airport would ease congestion at Santa Cruz. The redeveloped Juhu airport can cater to private jet and small turboprop planes, which constitute around 15% of CSI's total operations," said a ministry official. The project cost is estimated at around Rs 2,000 crore, and has taken on a sense of urgency as airlines fail to get new peak hour slots at CSI airport in

Mumbai, the country's financial capital. Work on the long-delayed second airport in Navi Mumbai will start only later this year.

IAI exploring JV for UAV production in India

Israel Aerospace Industries (IAI) is exploring a joint venture under the 'Make in India' initiative to produce unmanned aircraft in India. IAI's Corporate Vice President for India Operations said that the company is "in the process of picking a partner" and that once a suitable firm was selected, they would be ready to build UAVs "in two years." While IAI sources did not reveal the companies under consideration, it is understood that the shortlisted firms include Tata, Mahindra and the Anil Ambani-led Reliance Group.

Boeing and Tata establish aerospace facility in Hyderabad

On 18 June, Boeing and Tata Advanced Systems laid the foundation of a new facility in Hyderabad for their joint venture, *Tata Boeing Aerospace Limited* (TBAL). The joint venture has been established to co-produce Boeing AH-64 Apache

helicopter fuselages and other aerostructures, as well as to pursue integrated systems in aerospace. The Hyderabad production facility will eventually be the sole producer of AH-64 fuselages globally. Participating in the ceremony were Defence Minister Manohar Parrikar, KT Rama Rao, Telangana state minister of IT and Industries & Commerce, and other dignitaries from the Telangana state government.

Boeing and Tata had announced plans for the joint venture in November 2015 (*see Vayu VI/2015*) for manufacturing aerostructures and collaboration on integrated systems development opportunities in India. Boeing and Tata already have a history of cooperation, with Tata Advanced Materials providing composite panels for the power and mission equipment cabinets and auxiliary power unit door fairings for the P-8I maritime patrol aircraft, and TAL Manufacturing Solutions producing complex composite floor beams for the Boeing 787-9 and providing ground support equipment for the C-17 Globemaster III strategic airlifter.

Saab offers Gripen 'Made in India'

"Saab hopes to contribute to the government's 'Make in India' and 'Skill India' initiatives by setting up manufacturing facilities and training academies in the country", stated Jan Widerström, Chairman and MD, Saab India Technologies (in photo above) at New Delhi on 15 June. Saab executives from India and Sweden detailed the Company's plans to offer the new generation Gripen E/F multirole fighter to meet increasingly urgent shortfalls in the IAF's combat fleet. Beyond the obvious fillip to military capability, the Company re-iterated its intention to develop an educational backbone and a comprehensive aerospace manufacturing ecosystem in the country.

"Our concept of technology transfer is real as we are willing to give India comprehensive system and software control. In short, Saab is not only looking at setting up a base here, but also helping in the development of aerospace capability for many years to come," stated Widerström.

"We would train engineers in Sweden, as we're currently doing with Brazilian engineers for the Brazilian Gripen programme. We will train people in India and in Sweden to be able to design, develop, manufacture and maintain in India", added Mats Palmberg, Vice President, Industrial Partnerships at Saab Aeronautics.

Saab offers support on LCA Mk.1A

Saab India head Jan Widerström also confirmed on 15 June that Saab is indeed "in talks with HAL on various aspects regarding the Tejas Mk.1A version." He stated that HAL is "looking for sub-suppliers for major systems" including radar and EW (Electronic Warfare), areas where Saab feels it can be a productive collaborator. "We are offering the latest AESA radar to HAL for Tejas under the 'Make in India' umbrella, meaning that we are willing to set up the production line and produce it here in India," stated Widerström, before indicating that this would proceed independently of an Indian decision to procure Gripen fighters.

Mahindra contracted for Airbus Helicopters AS565 MBe Panther

Airbus Helicopters has awarded a contract to Mahindra Aerostructures for manufacture of AS565 MBe Panther airframe parts, to be produced at the Mahindra facility in Bengaluru. They will be shipped directly to the Airbus Helicopter production line in Marignane, France where they will be integrated with the rest of the airframe assembly.

L-R: Xavier Hay, President, Airbus Helicopters Division in India; SP Shukla, Group President, Aerospace & Defence, Mahindra & Mahindra; Fabrice Cagnat, Director - Make in India, Airbus Helicopters; Arvind Mehra, Executive Director & CEO, Mahindra Aerospace; Ben Bridge, Executive Vice President, Global Business, Airbus Helicopters; Stephen Roebuck, Director Business Development (Europe), Mahindra Aerospace

Mahindra Aerostructures is the first Indian company to receive a direct manufacturing contract from Airbus Helicopters as a Tier 1 supplier. Mahindra Aerostructures be embedded firmly in the Airbus Helicopters' global supply chain and bind the two companies in a long-term 'Make in India' partnership. "We are playing an active role in the development of a helicopter-focused Indian industrial eco-system, and are embedding Indian suppliers into our global supply chain," said Fabrice Cagnat, Director - Make in India, Airbus Helicopters. "The contract will allow us to qualify Mahindra Aerostructures as a Tier 1 supplier, establish a manufacturing relationship with them on the Panther, and also lay the ground work for a rapid acceleration in terms of industrialising production in India, in case we are selected for the Naval Utility Helicopter programme," he added.

Safran, HAL form engine MRO joint venture

Safran and Hindustan Aeronautics (HAL) have formed an MRO joint venture in India to support two types of engines used on HAL-produced helicopters, to service the Safran TM333 and HAL Shakti engines (Indian designation for the Ardiden 1H1). The Shakti powers HAL's Dhruv, as well as in the new Light Combat Helicopter (LCH), while the Ardiden 1U will power the future Light Utility Helicopter (LUH).

In the photo above are seen officials from HAL and Safran Helicopter Engines during the agreement ceremony signed at the Farnborough International Air Show on 11 July 2016.

BEL wins PSE Excellence Awards

Navratna Defence PSU Bharat Electronics Ltd (BEL) has won four PSE Excellence Awards 2015, instituted by the Indian Chamber of Commerce, Kolkata: second prize in 'Operational Performance Excellence', second prize in 'R&D, Technology Development and Innovation', 'third prize in Corporate Governance' and third prize in 'HR Management Excellence', under the Navratna category.

DST-Lockheed Martin India Innovation Growth Programme

Thirty innovation led start-ups were recognised under the 10th year of the India Innovation Growth programme on 6 June 2016. Speaking at a function organised by the team, Amitabh Kant, CEO Niti Aayog, stated that "If India has to grow at a rate of 9-10 per cent, we must become a great innovative society. For this we need to re-engineer our entire education system and spread the innovation eco-system to our schools, colleges, IITs and IIMs." Niti Aayog, under the Atal Innovation Mission is establishing 500 'tinkering labs' in schools and 20 incubation centres across the country, he added. Delivering his keynote address, Keoki Jackson, CTO, Lockheed Martin said, "Innovation is never easy – it requires great ideas, hard work, incredible persistence, help where you can find it, and even a bit of luck."

HAL-BEL in umbrella MoU

HAL and BEL have signed an umbrella MoU with an aim of mutual cooperation and knowledge transfer in avionics, with T Suvarna Raju, CMD HAL, SK Sharma, CMD BEL, and senior officials from both the DPSUs were present on the occasion. DK Venkatesh, Director (Engineering and R&D) at HAL and Dr AT Kalghatgi, Director (R&D) of BEL signed the MoU.

BEL CMD SK Sharma said that BEL was "pleased to be associated with HAL and share the respective expertise and competencies for the common objectives. I am sure such efforts will lead to greater indigenisation and self-reliance in defence technologies. This collaboration will support the 'Make in India' mission."

Samtel-HAL JV delivers 1,000th MFD

Samtel HAL Display Systems (SHDS), a joint venture between Samtel Avionics and Hindustan Aeronautics Limited, has already supplied 1,000 indigenously manufactured Multi Function Displays (MFDs) to HAL for integration into Sukhoi Su-30MKI fighters being produced under licence. SHDS is the only company to receive CEMILAC (Centre for Military

Airworthiness and Certification) Type Approval for MFDs in India, and this milestone implies that out of a planned fleet of 272 Su-30MKIs for the Indian Air Force, 143 would be flying with Indian-made MFDs.

The Samtel-HAL joint venture was set up in 2007 to address avionics requirements for a range of IAF platforms, both fixed and rotary wing. The display technology from the JV is leveraged not only for the Su-30MKI but also for the Tejas LCA, HJT-36 Intermediate Jet Trainer (IJT), Light Combat Helicopter (LCH) and Dhruv ALH.

Nammo establishes India Office

An official ceremony was held in New Delhi on 3 June 2016 to mark the establishment of Norwegian defence firm Nammo's presence in India. Representatives from the Indian Armed Forces and defence industries were present. The Norwegian Ambassador to India, Nils Ragnar Kamsvag, spoke on the occasion where the Norwegian Defence Attaché and representatives from the Commercial Section (Innovation Norway) also participated.

Through local presence and a newly established office in New Delhi, Nammo "is ready to support India in its defence modernisation programmes and to be an active participant in the 'Make in India' initiative."

"We have seen that the expertise, production cost and excellent quality of products manufactured by Indian industries correspond perfectly to several of our product lines. I believe we have great opportunities for cooperation ahead of us," said Kjell Kringsja, Senior Vice President Business Development in the Nammo Group. The Company is a leading developed and manufacturer of shoulder fired weapon systems and high-performance ammunition products for various weapon platforms, which it intends to co-produce in India for the Indian military, as well as for export.

BEL Financial Results for 2015-16

Bharat Electronics Limited (BEL) registered a turnover of Rs 7,522 crore for the financial year, representing a growth of 12 per cent over the previous year. Revenue from indigenous

BEL CMD SK Sharma at the press conference

technology was 86 per cent, with 40 per cent of materials by cost sourced from Indian companies, which company officials are keen to highlight as a 'Make in India' success. Induction of the Akash surface to air missile system with the Indian Army and Air Force, Schilka air defence gun upgrade for the Army, Integrated Sonar Suites and New Generation Sonars for the Navy are some of the major milestones for the past year. BEL's exports, totalling $ 85 million, represent a growth of 47 per cent in export performance. This includes export of a Naval Surveillance Radar to Myanmar, revenue through discharge of offset obligations and a range of products for platform fitment.

For the future, BEL has also introduced a slew of new products during the year such as 3D Surveillance Radar, Coastal Surveillance Radar, and Laser Warning System. The new Defence Systems Integration Complex launched at Anantapur (*see Vayu VI/2015*) is also "progressing satisfactorily." Investment of Rs 450 crore in stages is planned to expand BEL's missile systems business, while the company's JV with Thales is currently working on two programmes for domestic projects and also exploring the possibility of global exports through Thales. A three-year R&D plan (2016-19) is in place and a new division has been formed for Control Electronics under the Missile Electronics business area.

UPES to develop HADR payload for C-130J

The University of Petroleum and Energy Studies (UPES) is developing a payload prototype for the Lockheed Martin C-130J Super Hercules airlifter, with a $40,000 research grant awarded by

Lockheed Martin. The Payload will be used towards improved humanitarian aid support, disaster relief operations, medical evacuation and environmental/weather missions. Presently, in relief operations during disaster situations facilities such as water purification, sanitation, and electricity are set up separately, which consumes a significant amount of the crucial 'golden hours' (72-hour period immediately after a calamitous incident). The UPES-developed payload will help in considerably reducing set-up times in such situations.

Mr Utpal Ghosh, CEO & President, UPES, said, "We are extremely proud of this achievement by our students and faculty. This is a fitting testimony of the technical competencies developed by the students during the course of their studies, our focus on R&D and industry-academia interface."

K9 Vajra SP Howitzers for the Army

The Rs 4,500-crore contract for the K9 Vajra 155mm self-propelled howitzer, which had been under price negotiations since the beginning of this year, has reportedly been finalised, with the MoD forwarding the same to the CCS for approval. This will be the largest contract for weaponry to the private sector, with the MoD concluding negotiations with Larsen & Toubro for 100 such howitzers.

L&T, which has Samsung as its technology partner for the contract, will produce the guns in India under a JV company. Close to 50% of the gun will be indigenised and manufactured in India at L&T's Strategic Systems Complex at Talegaon near Pune.

DAC approves M777 howitzers

The Defence Defence Acquisition Council (DAC) has on 25 June approved procurement of 145 BAE Systems M777 Ultra-Light Howitzers (ULH) worth around $750 million for the Indian Army. The M777s will be procured under the Foreign Military Sales (FMS) route from the US Government, while offsets would be handled independently of the FMS process. BAE Systems has in the past made repeated commitments set up an Assembly, Integration and Test (AIT) facility in India, in partnership with the Mahindra group. Of the 145 M777s, 25 will be imported while the remaining 120

will be assembled in India. The DAC also reviewed the indigenous OFB 155m/45 Dhanush gun, and cleared an initial bulk production clearance of 18 guns (*see following item*).

Field trials for Dhanush howitzer

Final field trials of the indigenous Dhanush 155mm/45 howitzer commenced in June 2016, to be conducted over a six-month period, which will also test production-standard prototypes of the gun. Dhanush is based on the 1980s Bofors FH-77B 155mm/39 field gun design, aided by Transfer of Technology (ToT) from the Swedish company. The Army will put six such guns at various locations to test firing ability during summer and winter, across varied terrain, the last such before the Ordnance Factory Board (OFB) begins series production of the howitzer. The first three guns of the production-standard prototypes will undergo four months of summer trials from June to September. Between October and December, three more guns will be added and the entire lot will be tested in high altitude winter conditions. The MoD has set a stiff delivery schedule for the howitzers, requiring the first 18 guns to be delivered 18 months after contract signature, followed by another 36 guns over the next 12 months, and the remaining 60 by June 2020.

The Army's Field Artillery Rationalisation Plan (FARP), drawn up in 1999, aims to acquire between 2,800 and 3,000 155mm/52-calibre guns (towed as well as self-propelled) and a smaller number of air-transportable 155mm/39-calibre lightweight howitzers by 2027. The next revision of the Dhanush gun will incorporate a 52-calibre barrel, bringing it in line with the FARP requirements.

Surface Mine Clearance with BMP-2s

UK-based Pearson Engineering, in partnership with Bharat Earth Moving Limited (BEML), has been awarded a contract for 41 sets of the Surface Mine Clearance System (SMCS) to be mounted on Indian Army BMP-2 'Sarath' armoured vehicles. The contract between the Indian Ministry of Defence and BEML was signed in March 2016, with first deliveries to commence this year.

Exercise *Megh Prahaar*

The Mathura-based I Strike Corps of the Indian Army gave a demonstration on effective river crossings by armour, including T-90 MBTs and BMP-2 ICVs on 14 July 2016. This was along the river Yamuna opposite the cantonment to "showcase the variety of equipment, innovativeness of commanders, jointmanship, professional outlook and war waging potential of the 33rd Armoured Division." Interacting with the media was Lt Gen Shokin Chauhan, GOC 1 Corps.

Indigenous ASW torpedo 'Varunastra'

The ship-launched variant of the indigenous Varunastra heavyweight anti-submarine torpedo was handed over to the Indian Navy on 29 June by Defence Minister Manohar Parrikar. The 1.25-tonne Varunastra was developed by the DRDO Naval Science and Technological Laboratory, and will be produced by Bharat Dynamics Limited (BDL). Presently the *Rajput* and *Delhi*-class destroyers will be able to use the torpedo, along with future ASW ship classes. A submarine-launched version is also under development, and will be inducted at a later date.

DK Hota takes over as BEML CMD

Mr DK Hota assumed charge as Chairman and Managing Director of Bharat Earth Movers Limited (BEML) on 1 July 2016. He was formerly Director (Human Resources) at the Company and served in Hindustan Petroleum Corporation Limited (HPCL) for 30 years before that.

On taking over as CMD Hota said, "I believe that the 'Make in India' campaign of the Government of India is a golden opportunity for BEML to grow. With the given potential of the skills and experience, I am sure that the Company would rise to greater heights."

Vice Admiral G Ashok Kumar is DCNS

Vice Admiral G Ashok Kumar, AVSM, VSM assumed charge as Deputy Chief of Naval Staff on 6 June 2016. After having specialising in Navigation and Direction at Kochi in 1989, he served as Navigating Officer of INS *Beas*, *Nilgiri*, *Ranvir* and *Vikrant*. He has also been Executive Officer of INS *Brahmaputra*, and commanded INS *Kulish* and

Ranvir. He has also been the Chief Staff Officer (Operations) of the Western Naval Command. On promotion to Flag rank, he has held the assignments of Flag Officer Sea Training (FOST), Chief of Staff (COS) of Southern Naval Command and Flag Officer Maharashtra and Gujarat (FOMAG). As Vice Admiral, he has been the Commandant of the National Defence Academy.

Dr CP Ramanarayanan is new DG (Aeronautical Systems) at DRDO

Dr CP Ramanarayanan has been appointed Director General of Aeronautical Systems at the Defence Research and Development Organisation (DRDO) assuming office on 1 June 2016. He takes the place of Dr K Tamil Mani who retired at the end of May.

Dr CP Ramanarayanan, was previously Chief Controller R&D (HR) and has also served as the Director of GTRE Bangalore and Vehicle Research & Development Establishment (VRDE), Ahmednagar and has been Project Director for thermal propulsion development for heavy- and light-weight torpedoes at the Naval Science and Technological Laboratory (NSTL) at Visakhapatnam.

Air Marshal SK Ghotia is SASO Training Command

Air Marshal SK Ghotia took over as Senior Air Staff Officer at Headquarters Training Command in Bangalore on 20 June 2016. He was commissioned in the fighter stream of the Indian Air Force in December 1981, and has around 3,000 hours of flying experience on various aircraft, with over 1,000 hours of instructional flying. He has served as Commanding Officer of a fighter squadron, Chief Operations Officer, and Station Commander of a forward Air Base in South Western Air Command. He was also Air Officer Commanding of a special Air Operations Group in Central Air Command. He has served in a number of Staff appointments, including Director Intelligence at Air Headquarters, Staff Officer of Fighter Operations of Western Air Command and Principal Director Training (Flying) at Air Headquarters. He was the Assistant Chief of the Air Staff (Intelligence) prior to appointment as SASO Training Command.

Swedish General to head UNMOGIP

A serving Swedish Army General will be the new head of the United Nations mission tasked with monitoring the ceasefire line between India and Pakistan in Jammu and Kashmir. Major General Per Gustaf Lodin, also a logistics expert, was appointed by UN Secretary-General Ban Ki-Moon as the Chief Military Observer and Head of Mission for the United Nations Military Observer Group in India and Pakistan (UNMOGIP). He succeeds Maj Gen Delali Johnson Sakyi of Ghana, who completed his two-year term on 2 July 2016. The Government of India has maintained that UNMOGIP has outlived its utility and is irrelevant after the Simla Agreement and the consequent establishment of the Line of Control (LoC). However, according to the Security Council mandate given in Resolution 307 of 1971, UNMOGIP observes and reports on ceasefire violations along and across the LoC and the working boundary.

Lockheed Martin CEO visits India

"Lockheed Martin's commitment to the Indian government's strategic 'Make in India' policy, the national 'Skills Initiative' and to working with industrial partners in India to expand its business footprint" was reportedly discussed by the Corporation's Chairman, President and CEO Marillyn Hewson during her visit to New Delhi in early July.

Meeting with political leaders, senior government officials and leading Indian industrialists, Hewson highlighted Lockheed Martin's sponsorship of the India Innovation Growth Programme (IIGP) as an example of effective partnership in action.

Backed by Lockheed Martin since 2007, IIGP is a partnership involving industry and academia in both India and the United States. It has underpinned Prime Minister Narendra Modi's 'Start Up India' call by supporting more than 400 innovators and start-up companies since launch. "As we continue to build on the momentum and traction gained in India over the past 25 years, Lockheed Martin has proven expertise leveraging our innovative technologies to help engineer success with our customers and partners," said Hewson. "I look forward to growing our 25-year story in India and to establishing greater and more meaningful partnerships that will help grow the Indian economy and community."

ISRO's Reusable Launch Vehicle Technology Demonstrator

RLV-TD Successfully Flight Tested

On 23 May 2016, ISRO successfully flight tested India's first winged body aerospace vehicle operating in the hypersonic flight regime.

This experimental mission began with an HS9 solid rocket booster carrying the Reusable Launch Vehicle Technology Demonstrator (RLV-TD) lifting off from the Satish Dhawan Space Centre's First Launch Pad at 0700 h IST. After a successful rocket burn lasting 91.1 seconds, the HS9 and RLV-TD 'stack' coasted to a height of about 56 km. There, RLV-TD separated from the booster and further ascended to a height of about 65 km.

From that peak altitude, RLV-TD began its descent, with atmospheric re-entry at around Mach 5. The vehicle's navigation, guidance and control systems accurately steered the vehicle during this phase for safe descent. After successfully surviving the high temperatures of re-entry with the help of

RLV-TD getting ready for transportation

RLV-TD lift off

RLV-TD at launch pad

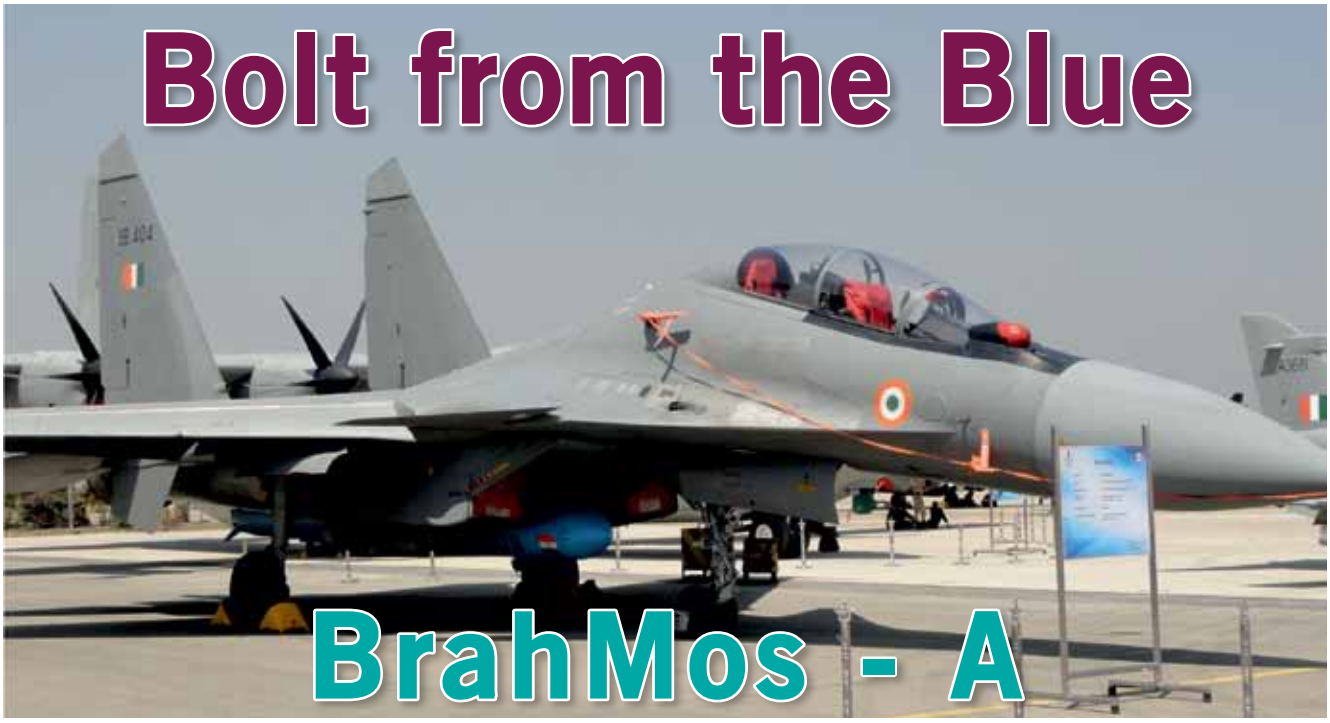
RLV-TD moving towards launch pad

its Thermal Protection System (TPS), RLV-TD glided down to a pre-defined landing spot in the Bay of Bengal, some 450 km from its launch site at Sriharikota, bringing the mission to a successful conclusion. The vehicle was tracked throughout the flight from ground stations at Sriharikota and a shipborne terminal. Total flight duration from launch to landing was about 770 seconds.

The mission validated critical technologies such as autonomous navigation, guidance and control, reusable thermal protection system and re-entry mission management. "We had three objectives for this launch: To test the characterisation of the aero-thermo dynamics of hypersonic flights; to test the autonomous mission management of hypersonic vehicles; and to test the necessary re-entry technology for the vehicles," said K Sivan, Director of the Vikram Sarabhai Space Centre, where the RLV is developed.

ISRO officials also acknowledged the support of the Indian Coast Guard and National Institute of Ocean technology (NIOT) for assisting the mission with mid-sea wind measurements and shipborne telemetry respectively.

Bolt from the Blue



BrahMos - A

Developed by BrahMos Aerospace which was established in 1998 through an inter-governmental agreement, the PJ-10 BrahMos cruise missiles represent one of the finest joint ventures in Indo-Russian defence cooperation, represented by India's Defence Research & Development Organisation (DRDO) and Russia's NPO Mashinostroyeniya (NPO Mash). There are promising prospects in terms of futuristic defence technology with 19 February 2013 now celebrated as 'Partnership Day'.

The Company was instituted with an authorised capital of $250-million with 50.5% from India and 49.5% from the Russian side. The basic Block I naval version Anti-Ship Cruise Missile (ASCM) was inherited from Russia's P-800 Onyx/ Yakhont (SS-N-26) combining a low Radar Cross Section (RCS) with an active radar homing seeker to facilitate fire-and-forget launch. Varieties of flight trajectories including sea-skimming or terminal pop-up followed by a deadly dive are meant to complicate all defences of the adversary. Mid-course guidance is inertial, developed and refined by Indian scientists. A 290-km (likely a deliberate underestimate prior to India's membership of the Missile Technology Control Regime), long flight range with high supersonic (Mach 2.8) speed leads to lower target dispersion and quicker engagement and higher destructive capability aided by the large kinetic energy of impact. In most of the cases the target warship is denied sufficient time to react even if alerted at 'final moments' as violent 'S' shaped evasive manoeuvres are performed by the missile even at such high supersonic speeds.

> The 'masterpiece' of the defence industries of India and Russia, the BrahMos missile has got good chances for export as well. As stated by a BrahMos Aerospace official, "The Russia-India committee has determined 14 countries with whom we can discuss the supplies of BrahMos missiles. The list includes Chile, Vietnam, the United Arab Emirates, South Africa among others." According to BrahMos, "countries which maintain good relations with both India and Russia, are on the list." The first contract could well be signed later in 2016.

The missile, now arming multiple Indian Navy (IN) warships, appears to have been developed to defeat the increasing sophistication of ship-based defences comprising of longer-ranged and enhanced flexible phased-array radars in combination with point-defence missile systems, 'closed-loop' Close-In Weapon Systems (CIWS) and smart decoys.

BrahMos may be an even more deadly ASCM if Indian software designers have matured the already formidable guidance system of the BrahMos predecessor, the Onyx/Yakhont which has accumulated all the NPO Mash experience in developing electronic systems of artificial intelligence. Thus in case of a salvo launch, a flock of BrahMos ASCM (including ship, submarine and air launched) will be able to allocate and range targets by their importance and choose the attack implementation plan. Besides taking care of the Electronic Counter Measures (ECM) and Electronic Counter-Counter Measures (ECCM) data, along with methods of evading fire of the enemy's air defence systems, the missiles are programmed to ensure destruction of the chief target in an aircraft carrier battle group (CVBG) or surface action group as priority, followed by destruction of other ships by the remaining missiles, eliminating in the process the possibility of expending multiple missiles on same targets.

The BrahMos-A air launched variant is initially being integrated with Indian Air Force Sukhoi Su-30MKI air dominance fighters with a successful trial flight undertaken on 25 June 2016. The missile is mounted on a specially built pylon along the centreline of the aircraft between the two separated engines, a concept that provides favourable

aerodynamic cross section. The integration of the missile guidance system into the Su-30MKI's fire-control system is facilitated by some specific software protocol conversions written in order to make the Indian-produced components interface with the Sukhoi's on-board main-mission computer. The BrahMos-A in an anti-shipping role will be much more formidable than the presently operated Kh-31A (AS-17 *Krypton*), which is restricted to 70 km range.

BrahMos-A does not require a launch tube as the booster is made lighter (and ignites after separation from the airborne platform) and the nose cone redesigned. BrahMos-A will be 'lighter' at 2,500 kg with a 300 kg warhead while the advertised range as of now remains at 290 km. BrahMos-A will be capable of decimating enemy capital warships "with impunity" and yet keep Su-30MKI launch platforms outside the reach of the enemy's longest range Surface-to-Air Missiles (SAM). If the target's range exceeds that of the Su-30MKI's *Bars* (Panther) radar, the BrahMos-A guidance system will be fed target designation by Airborne Early Warning & Control (AEW&C) and Long Range Maritime Patrol (LRMP) platforms. In fact 'in due course' Su-30MKI *Bars* radars are to receive upgrades in stages, with Stage 1 upgrades retaining the Passive Electronically Scanned Array (PESA) antennae yet with enhanced radar performance and operating modes. At Stage 2, Bars will acquire Active Electronically Scanned Array (AESA) antennae being developed for the Indo-Russian Fifth Generation Fighter Aircraft (FGFA) programme.

Additionally the Indian Navy Ilyushin IL-38 LRMP platforms remain candidates to carry the BrahMos-A. Little known yet as a parallel development and as part of the Alfa next-generation airborne reconnaissance and strike system, NPO Mash unveiled the Yakhont-M air-launched supersonic ASCM at a MAKS air show, which shares elements with the Indo-Russian PJ-10 BrahMos. Armed with multi-sensor guidance to engage surface ships and ground targets at up to 300 km, reconnaissance and target acquisition are to be provided by radar and electro-optical sensor equipped "ultra-light" (800-kg) Kondor Low-Earth-Orbit (LEO) satellites. Its multi-role radar provides high-resolution images along two 500-km sectors, left and right of the satellite orbit. As distinct from Western spacecraft, the Russian satellite features a collapsible six-metre parabolic antenna rather than a heavy-duty phased-array structure so that mission-control experts can target this parabolic antenna and rapidly scan different areas while the satellite's onboard radar will also provide 3D images for digital terrain models.

With modifications in software, BrahMos is also being employed as a Land Attack Cruise Missile (LACM). Presently stand-off land attack is performed by Kh-59ME with TV command guidance. The 930-kg missile with a warhead weight around 300-kg remains firmly subsonic at Mach 0.72 to 0.88. The quest for a BrahMos Block II LACM variant was hinted at a test at Pokhran during December 2004, the missile being equipped with special image processing software for terminal homing. Although not officially stated, this could well be a Digital Scene Matching Area Correlator (DSMAC) variant, which uses a zoom lens to collect images and matches them with the snaps of the approach to the target stored in the memory. Thus precision surgical strikes against an array of enemy counter-force and counter-value targets ranging from airfields to overland communications, command and control centres and powerful air defence installations is facilitated.

During the Pokhran test, BrahMos searched, located and destroyed a 50-cm thick concrete bunker with pinpoint accuracy. The version has already been transferred to the Indian Army for land based applications (being operated as a ground-launched tactical missile on mobile launchers). The BrahMos Block III recently tested, employs added features for enhanced manoeuvrability, enabling terminal 70 degrees steep dive endgame (a future version with 90-degrees steep dive capability is under development) to enable surgical strike at mountain areas and high value naval targets including aircraft carriers. During the test carried out in May 2015, BrahMos flew through multiple waypoints prior to striking the target with pin-point accuracy (within 5 metres). Redundancies in guidance system is another plus point and includes Inertial Navigation System (INS), Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), GAGAN with further provision for Indian Regional Navigation Satellite System (IRNSS). Present BrahMos Aerospace Chief Executive Officer and Managing Director Sudhir Kumar Mishra also asserted that India has by now "mastered canisterisation of the BrahMos missile."

Needless to say, the IAF's Su-30MKI squadrons, forming back-bone of the IAF striking force, when armed with BrahMos-A will be in a position to dominate and "dictate terms" throughout the Indian Ocean region especially if permitted to conduct 'one-way missions' and retrieving at allied bases in West Asia and the Pacific islands.

Sayan Majumdar

Red Flag-Alaska 16-1

The Indian Air Force heads West!

A 14 Squadron Jaguar rockets out of Eielson AFB during Exercise Red Flag-Alaska 16-1

On 3 April 2016, the largest-yet Indian Air Force contingent to take part in a foreign air exercise, headed west to participate in Exercise *Red Flag-Alaska* in the USA. A total of 12 aircraft from different IAF units made the long journey to Eielson Air Force Base in Alaska, almost literally the other end of the globe. The *Red Flag* exercise was held from 28 April to 13 May, and had four Su-30MKIs, India's frontline air-dominance aircraft, four Jaguar Darin II strike fighters, two Il-78MKI mid-air refuelers and two Boeing C-17 Globemaster III airlifters. The two Il-78s from Agra Air Force Station supported the fighters with multiple mid-air refuelings during on the epic 18,800 km journey to the USA.

Prestigious

Red Flag-Alaska (RF-A) is a series of Pacific Air Forces commander-directed field training exercises for US and partner nation forces, enabling joint and international units to exchange tactics, techniques and procedures while improving interoperability in a realistic threat environment. With more than 75 aircraft and 1,400 participants, RF-A 16-1 featured a strategic – and rare – involvement by the IAF. US Air Force Colonel Brian Toth, 354th Operations Group commander, attributed participation of foreign military forces to the overall success of RF-A exercises. "Through the initial planning meetings for each *Red Flag* iteration, we discuss the end goals of each exercise and it is up to those countries' representatives to acknowledge which missions would most benefit their particular needs at that time," said Toth. "However, the realistic training environment we aim to provide each iteration is only made possible with the participation of our partners and the hard work they put in throughout the exercise."

Key highlights

A team of over 170 IAF personnel took part in the Exercise for which the IAF had set certain specific objectives. "The objective of this inter-continental deployment was not only to showcase the IAF's capability in undertaking integrated air ops but also to imbibe operational lessons from the exercise engagements, which will help us add more teeth to our overall war waging capabilities," said the detachment commander, Group Captain Hirendra Assudani. The Exercise Director, Wg Cdr Saumitra Tamaskar, complemented his colleague by stating, "Having set out with well-defined objectives, the IAF contingent's effort over the month ensured that they take back important lessons which will help undertake operations across a wide and diverse spectrum and meet any future challenges."

This was the first time that the IAF sent two combat types across the Atlantic at the same time. Previously, IAF Jaguars participated in the *Cope Thunder* exercise (precursor to *Red Flag-Alaska*) in 2004 and Su-30MKIs went to *Red Flag* at Nellis Air Force Base (Nevada) in 2008. During this year's exercise, the IAF Jaguars flew as part of the 'Blue Forces' (friendly) while the Su-30MKIs flew largely in offensive counter air operations in which they provided cover for the strike elements of *Red Flag-Alaska*. The Jaguars undertook integrated strike missions dropping practice bombs over the world-renowned JPARC Air-to-Ground Range. As on previous occasions, the IAF fighters flew with their radars switched off during the exercises, so as not to reveal their electronic signatures.

Overcoming challenges

With thousands of kilometres between them and home, maintenance airmen from No.14 Squadron from Ambala experienced

IAF and USAF personnel interact on the ramp at Eielson

Trio of IAF Su-30MKIs of No.15 Squadron lined up at Eielson admidst a downpour

USAF F-16C taking off with practice munitions

Members of the IAF contingent with photographer Kedar Karmarkar (centre)

far different climate, terrain and work practices than they were used to while they participated in RF-A. While at Eielson they simulated the first 10 combat sorties during the surge of a conflict, working alongside their counterparts from around the world in the cold early mornings and into the mosquito-filled evenings to keep their fighters in top working order. "We are here to support pilots while they hone their skills of combat flying, but we learn valuable lessons throughout the experience that will help our maintenance team improve their skills," said Squadron Commander Latish Palakkot, 14 Squadron Officer in charge of maintenance. "Very seldom do we get to see so many airframes from so many fleets from whom we can take positive work practices and apply it to our routine." While the operational tempo they experienced at Alaska was not far from what they experience at Ambala, No.14 Squadron airmen had to learn to overcome weather uncommon from their normal working environment. "The mornings were much colder than home, so its really showing how our maintenance team could overcome challenges and get the mission accomplished anywhere in the world," said Wing Commander M Maharajan, No.14 Squadron's senior engineering officer.

Taking lessons home

Colonel Toth complimented the IAF on their participation during Red Flag, saying, "The IAF's participation has been extremely good from my perspective. For most nations it takes an exercise or two to step up to meet the requirements of a Mission commander. The IAF has been mission commander three times and also performed the package commander roles and they have done a tremendous job." The IAF is keen on joining the American 'Flag' exercises more often but budget is the biggest constraint. Defence Minister Manohar Parrikar has said that Indian Air Force gains by participating in international combat exercises, especially when its fighters are pitted against US F-15s, F-16s and F/A-18s, of which the F-16s are used by Pakistan. So the IAF takes the middle road and joins approximately once every five years. Nevertheless these exercises contribute tremendously to the skills of IAF servicemen both in the air and on the ground. The Su-30MKIs immediately put their newly acquired expertise into practise, as on the return flight to India they went to the United Arab Emirates to participate in the aerial exercise *Desert Eagle II* (*see separate article in this issue*).

Text: Remco Stalenhoef
Photos: Kedar Karmarkar

IAF Il-78MKI amid dramatic Alaskan scenery

Exercise Desert Eagle II

View from the cockpit of a UAEAF Mirage 2000-9 with another Mirage and an IAF Su-30MKI in formation

Desert Eagle II, the second-ever bilateral exercise between the Indian Air Force and the United Arab Emirates Air Force (UAEAF), commenced on 22 May 2016, as IAF fighters were transiting back to India after *Red Flag Alaska*. The ten-day air combat exercise had IAF Su-30MKIs and UAEAF Mirage 2000-9s and F-16 Block 60s carry out numerous sorties from Al-Dhafra Air Base, Abu Dhabi. A wide variety of missions were flown in the Beyond Visual Range (BVR) environment with varied levels of complexity. Mission commanders from both sides participated in the Exercise and availed the opportunity to draw "valuable operational lessons." Despite the extremely hot and arid conditions, with temperatures well beyond 40°C, IAF maintenance support staff succeeded in maintaining high aircraft serviceability.

Speaking about the overall exercise, IAF contingent leader Gp Capt H Assudhani said, "This was an excellent opportunity for both the Air Forces to learn from each other and exchange mutually beneficial best practices."

The UAE and India have strong bilateral relations, with an 'Agreement of Defence Cooperation' signed during an earlier visit by the Chief of Staff of the UAE Armed Forces to India in 2003.

The Indian and UAE contingents at conclusion of bilateral exercise 'Desert Eagle II' at Al-Dhafra Air Base, Abu Dhabi

The relationship has been given further impetus over the past few years, and both nations have articulated "resolve to engage with each other to foster greater security cooperation."

IAF Su-30MKI and UAEAF Mirage 2000-9 during a sortie over the desert

The Old Order Changeth :

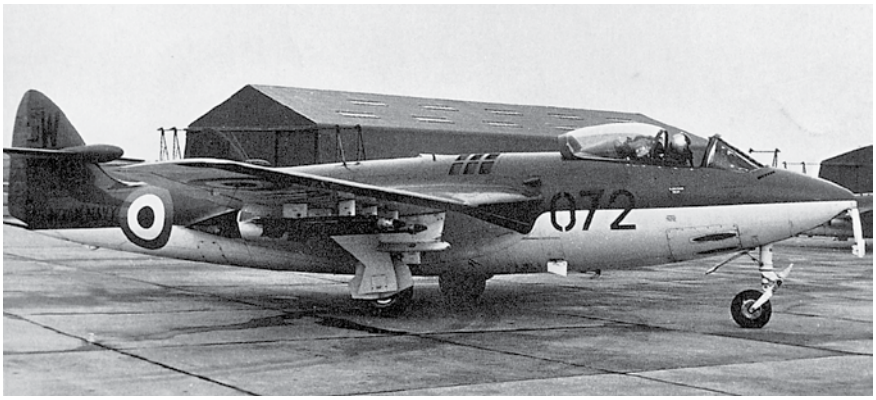
The Elegant Sea Hawk

Admiral Arun Prakash reminisces about the transition of the 'White Tigers' from the trusty Sea Hawk to the remarkable Sea Harrier, and now to the new-generation MiG-29K

Having allowed my ardour for aerobatics to exceed my flying skill, I paid dearly for it, receiving my 'wings of gold' nine months later than my fellow trainees. During the third successive loop in a de Havilland Vampire Mk.52, she flicked into a spin, from which I couldn't recover. Since this version of the Vampire did not have an ejection seat, I had to struggle a bit to egress the cockpit from the spinning machine. The parachute worked fine, but a hard landing led to a broken collarbone and I missed graduation day.

Thus, when I arrived at NAS Dabolim, in end-1968, I was in a great hurry to convert to the Sea Hawk and catch up with everyone else. Having received the Pilots Notes for weekend reading, on Monday morning I went up with the Boss, Lt Cdr (later RAdm) SK Gupta, in a Vampire Mk.55 trainer for a couple of trips. In the air, I was shown the Sea Hawk circuit and speeds and the following day, 22 November 1968, I went solo in a Sea Hawk Mk.100.

As much a pleasure to behold as a delight to fly, the Sea Hawk captivated me from the moment I cast my eyes on her simple but elegant profile. Later, when I flew the Hawker Hunter, I could not help



thinking of it as a 'swept-wing Sea Hawk' in more ways than one. Her powered ailerons gave this straight-wing fighter good handling qualities, and the novice found her virtually vice-less. She made a steady weapon platform for air-to-air and air-to-ground firing, but the Nene engine's 5,300-lb thrust was inadequate for indulging in air-combat. The most distinctive feature of the aircraft was the ingenious arrangement of bifurcated intakes and exhausts, which permitted fuel tankage in the fuselage, fore and aft of the engine. The downside of this arrangement was the frequency of fuel tank fire-warnings. Generally triggered by hot gas leaks from cracks in the exhaust, the red light and horn were startling but one learnt to take them stoically. On account of this, the max RPM, except for carrier launch, had to be reduced to 97%.

As I neared the end of the conversion syllabus, the airfield's Mirror Assisted Dummy Deck-Landing (MADDL) sight became the Mecca. The landing-sight consisted of a large polished mirror with a row of green datum lights on either side. Reflected in the mirror was an orange blob of light (the 'meatball'), which indicated to the pilot whether he was high, low or 'roger' on the approach. The carrier circuit was flown at 400 feet, and having sighted the 'meatball' during the finals turn, one had to fly it 'roger' down to touchdown. The approach required precision flying, but the touchdown was technically a 'crash' because if you 'flared' to cushion the landing, your arrester hook would miss the wires. An aspirant for deck-qualification had to do 80-100 of these approaches before being allowed a go at the carrier.

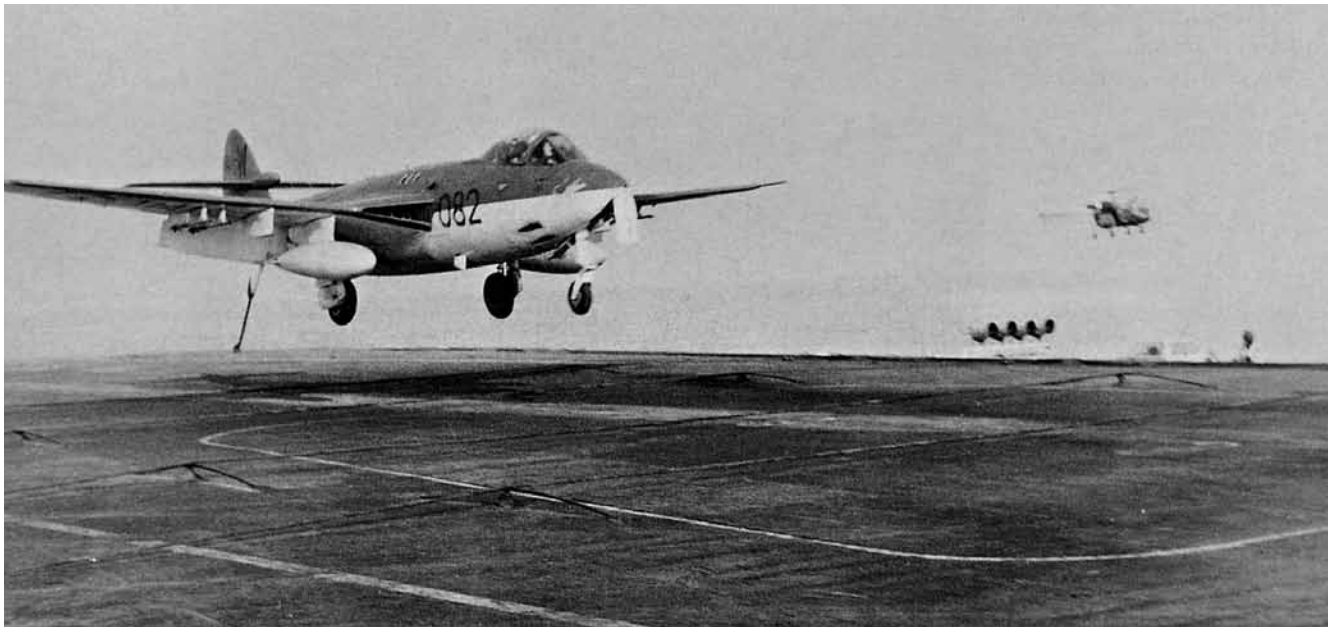
The day finally came when a bunch of us 'sprogs' were deemed fit to have a shot at the carrier. By now the monsoon had rendered the west coast inhospitable for carrier operations, so we ferried our aircraft from Dabolim to Meenambakkam on the east coast and awaited a rendezvous with 'Mother' (as the aircraft carrier was nicknamed) somewhere at sea.

It was a brilliant day in the Bay of Bengal, and a few minutes after departing Meenambakkam, I saw the carrier and her 'plane-guard' frigate. From 10,000 feet the ship looked ridiculously small and I was appalled that I was expected to land on a matchbox-sized object moving at 15 knots! However, by the time I descended to 400 feet, she looked bigger (although not much) and the adrenaline had started pumping furiously. Having made two good approaches, I was told to lower my hook and land. On the third approach, as I neared the deck, I involuntarily 'flared'. As the aircraft hit the deck, FLYCO (Flying Control on board the carrier) screamed on the radio, "Bolting! Go round!" I nursed my shuddering Sea Hawk back into the air and, on the next approach, made a successful 'arrest'. The 'catapult shot' was to follow.

Early next morning I sat on the catapult, left fist jammed behind the wide open throttle, and right hand gingerly holding the stick. As the shuttle fired, I recall my startled yell and the brief 'grey-out' followed by the clumsy grope for the undercarriage button. And then the ecstasy of getting airborne after a carrier launch. By the end of the day, I had done 3 deck-landings and attained the 'Holy Grail' of DLQ – deck landing qualification.

A row of Sea Hawks starting up on the carrier's flight deck always lent a touch of melodrama to the scene. The whoosh of the starter cartridges firing all together, accompanied by plumes of black smoke, the synchronised spreading of wings, and then the urgent hand-signals of colourfully dressed flight deck crew—all this reminded one of a carefully orchestrated ballet.

The 'Hawk was spartanly equipped – even by 1960s standards – with just two VHF sets and a homing device called 'Green Salad' that never worked. The cockpit cooling was generally ineffective, and at low level, you could lose a couple of pounds in a sortie! By night, the very basic instrumentation made carrier-flying quite exciting. But weapon work on the splash target, anti-shipping strikes, close air-support and interception exercises were great fun.

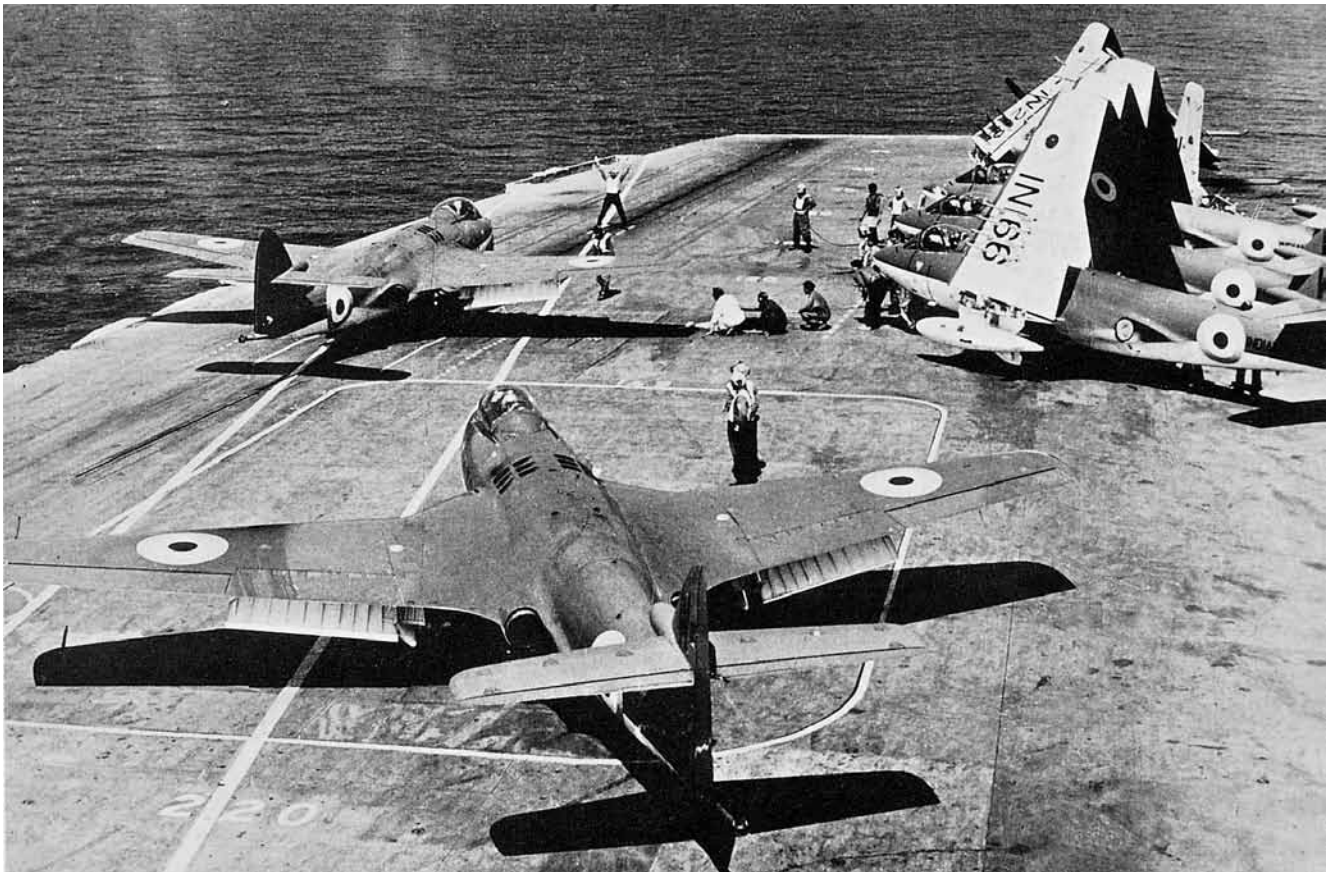


The Bangladesh War saw the White Tigers embarked with a substantive force of 18 Sea Hawks. The Pakistan Air Force had a squadron of F-86 Sabres, but they were kept busy by the IAF. The Tigers ranged far and wide across Bangladesh. Between 4 and 14 December 1971, using rockets, bombs and guns, the squadron devastated

PAF air bases, enemy gun boats, harbours, ammunition dumps, merchant shipping and troop positions *(see lead image)*.

These air-interdiction operations, and the presence of the carrier offshore, accelerated the capitulation of Pakistani forces and surrender of 93,000 troops. Frequent damage from anti-aircraft fire was repaired on board, and to the eternal credit of the maintainers, all eighteen Sea Hawks remained flyable till until end of the operation. The carrier had a boiler problem and was restricted in speed. In the light wind conditions prevailing, a full-load launch on the Sea Hawk could be a chancy affair. But the catapult held out and so did the aircraft; there were no accidents, and our sailors fixed all the battle damage. To my everlasting regret, I was on deputation to the Indian Air Force for the entire duration of the War.

It was five years later, in March 1976, that the *Vikrant*'s catapult fired its first and only 'cold shot'. The newly appointed Squadron CO, Commander Peter DeBrass, was on the catapult for his first launch after taking over. With the bridle tensioned and



engine at full power, the hold-back parted and the Sea Hawk rolled slowly forward and plunged over the bows of the ship. With great presence of mind and cool judgement, Pete waited until the ship had crossed over him before pulling the blind. Fortunately he was thrown clear by the propeller wash and promptly picked up by the SAR helicopter.

In all, the Indian Navy acquired 73 Sea Hawks of different marks, from the UK and Germany. They served with great distinction for over two decades, inducting three generations of Indian naval aviators into the esoteric art of carrier flying. The first of these aircraft to join the IN were nine ex-RN Sea Hawks refurbished to FGA Mk.6 standard by Armstrong-Whitworth and delivered in 1960. A year later, twenty-two more FGA Mk.6s were purchased ex-RN and an order for fourteen newly built FGA Mk.6s placed at the same time. The last buy of Sea Hawks by the IN was 10 Mk.100s and 18 Mk.101s, acquired from the German Marineflieger in 1966. These were 'night-

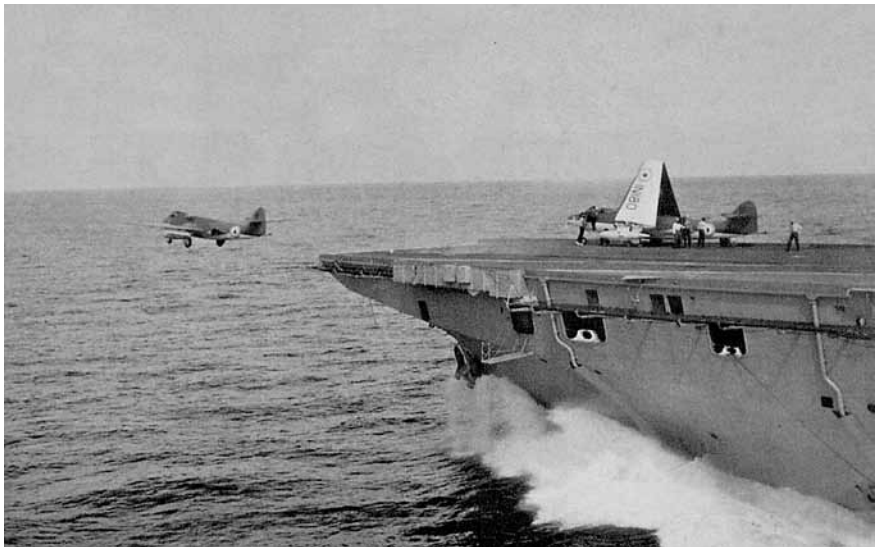
fighters' of sorts, carrying a podded radar and a Sidewinder AAM.

Indian Sea Hawks flew in three different liveries. The Mk.6s from IN151 to IN179 came in the traditional maritime scheme of grey top and white belly and undersurfaces. IN180 to IN195 were painted a menacing glossy black overall. The Mks.100/101 also had the conventional maritime camouflage, with variations in shade. All IN Sea Hawks bore the leaping White Tiger on both sides of the nose, with a roundel and the word 'Navy' on the aft fuselage.

The first deck landing in a Sea Hawk on board INS *Vikrant* was carried out on 18 May 1960 by Lt Cdr RH Tahiliani (later Admiral and CNS) flying IN151, and the last launch was made by Lt Sanjoy Gupta on 8 May 1978, in IN249. On 16 December 1983, as I was leading a flight of three Sea Harriers, on delivery from Yeovilton, a lone Sea Hawk – IN238, flown by Commander UP Bapat – rose to greet us in the sky over NAS Dabolim. Thus ended

the saga of the graceful Sea Hawk in Indian skies *(Photo on left)*.

The Fleet Air Arm owes a great debt of gratitude to this tough and trusty machine for having introduced IN aviators to the esoteric skills of embarked aviation, and for forgiving them many trespasses. The 'Hawk was no doubt instrumental in laying a firm foundation for fighter aviation in the IN.



The Beloved Sea Harrier

Two decades after the 'White Tigers' first arrived on the shores of UK in 1961, to train on the Sea Hawk, Lieutenant (later VAdm) Shekhar Sinha and I landed in Heathrow on a cold April morning in 1982. I was the Squadron Commander and he the QFI of the dormant INAS 300 (*nom de guerre*: 'White Tigers') waiting to be re-incarnated with the Sea Harrier.

Within 24 hours we found ourselves being towed behind a high-speed RAF launch, in the freezing waters of the English Channel, as part of the Sea Survival Course. We then rushed off by train to RAF Brawdy, in a remote corner of South Wales. The Airspace Orientation Course at RAF Brawdy was meant to familiarise us with UK ATC procedures but we found that it also facilitated comprehension of English as 'she is spoke' by the Scots, Welsh, Cockneys and others on R/T.

During a low-level navigation sortie on a Jet Provost Mk.IV, the engine quit and I found myself practicing the recently learnt sea-survival techniques after ejection into a frigid mountain lake. By the time the SAR Sea King arrived to winch us up, I had contracted mild hypothermia, which took the RAF doctors two days to cure. My instructor – a young Flight Lieutenant – was not so lucky and suffered a compression fracture.

In May 1982, we arrived at Air Force Station Wittering, known as the 'Home of the Harrier' from where two RAF squadrons (in addition to two RN air squadrons) were in the process of embarking the Task Force which was sailing for the Falklands War.

'White Tigers' two: Arun Prakash and (stuffed) white tiger with Sea Harrier of INAS 300

Although we had flown a few hours on the Alouette, it did little to prepare us for the challenges of the Harrier we were to face in the Operational Conversion Unit. Early in the course, the RAF Flight Commander graphically emphasised the need for alertness in the cockpit with this authentic but crude advice: "Gentlemen, only Harrier pilots and astronauts fly on jet-thrust. But never forget for even a moment that the cold clammy hand of the Harrier lies, eternally, between your legs. One mistake and you'll go – ouch!"

The gruelling weeks that followed saw us unlearning much of what we knew of 'conventional' flying and learning the art of 'vectored' thrust. Operating a small lever next to the throttle could swivel the four exhausts of the Pegasus from right aft to nearly vertically down. Downward nozzle selection made a number of things happen in rapid succession. As it slowed and the wings lost lift, the Harrier rapidly turned into a 'flying brick.' Below 100 knots, the aircraft was totally thrust dependent and directionally unstable – requiring the use of small puffer-jet controls to turn and minimise sideslip. Approaching zero speed, height was controlled by thrust and once you went past 100% rpm, JPT (Jet Pipe Temperature) became critical. Fuel, water and JPT limitations often demanded that you land smartly after coming into hover.

The OCU syllabus focused mainly on V/STOL operations – take-off and landing in four different ways (conventional, rolling, creeping and vertical) at speeds between zero and 160 knots. In addition to short-

strip and VTOL pad operations, we also did some instrument and night flying and were introduced to air-combat with VIFF (Vectoring In Forward Flight).

Together with two Spaniards and half a dozen RAF and RN pilots we graduated after completing 30 hours of flying on Harriers T.4 and GR.3. An OCU 'rite of passage' was the 'hover-pot' to celebrate one's first solo hover. The celebratory beer came in a bulbous flask, with a slim three-foot long neck, called the 'hover pot,' which had a raw egg at the bottom. Unless you tilted the hover pot at exactly the correct angle, you were either sucking air or had beer and egg on your face.

The Pop-Surge Googly

We now learnt that the IN Sea Harrier FRS Mk.51 delivery programme had suffered a setback due to an engine problem. The aircraft had experienced unexplained engine-surges during acceptance flights and since Rolls Royce had no explanation, they sought a pause while they tried to find a fix. The consequent change in schedule saw Shekhar and I temporarily parked in the BAe Flight Test Centre at their Dunsfold works, then engaged in assembly of Hawk trainers.

BAe's Chief Test Pilot, John Farley, arranged for us to fly the company's Harrier trainer known by its civil registration, G-VTOL. Uniquely, G-VTOL, a former prototype, was not equipped with a head-up display (HUD), and over the next few weeks we experienced some 'seat of the pants' V/STOL flying with BAe test pilots. Occasionally, we would also hop a rear seat ride in the Hawks being test flown.

Yeovilton Ahoy!

The surge problem having been resolved, our Sea Harriers finally hovered into sight, about six months behind schedule. The official delivery of the first Sea Harrier FRS Mk.51 took place in a hangar in Dunsfold on 27 January 1983, with a proper 'Muhuratham' ceremony. IN601 was garlanded with marigolds and had a coconut broken on its nosewheel before being formally received by the Indian High Commissioner.

By February 1983 the IN detachment commenced functioning at RNAS Yeovilton as a lodger of HMS *Heron*. About 200 technical personnel, who had been attached to various UK vendors, began to converge on Yeovilton. An IN Training Unit (INTU) was formed, to conduct operational flying and maintenance training, with a core of three RN/RAF Harrier pilots, an air-engineer and some Chief Petty Officers on loan to the IN.

Soon after our arrival, two more new jets, IN601 and 602, displaying the White Tiger on nose and tail, arrived in Yeovilton, but deliveries remained slow, and by November 1983 we had received only five fighters. No. 1 Operational Flying Training (OFT) Course consisting of Sanjoy Gupta (AWI), Shekhar Sinha (QFI), RT Rajan (from the Harrier Project Team) and I commenced in February 1983, with a trainer borrowed from 800 Squadron next-door.

The challenge of settling a 250-strong Indian community, including some families, into sleepy Somerset villages without creating a social upheaval seemed a daunting task. But I was delighted to find that the natural charm of our sailors had soon won over most of their land-ladies! Our performance in sports, and warm Indian hospitality, extended socially, won us many friends in the RN air station.

During a courtesy call on the elderly village GP, I found him poring over tomes on tropical medicine. Fortunately, the worst he had to cope with was measles and mumps. Yeovil General Hospital, did, however see three babies being born: one each to Ajit Thosar, Shiv Kumar and Robin Dhowan (then Squadron Direction Officer and later CNS).

Joys of UK Flying

The OFT course got underway in April 1983 and the next few months, were spent in learning the 'black art' of using the Ferranti Blue Fox search/intercept radar. This proved to be quite a challenge for pilots used to flying a single-seat Sea Hawk, bereft of avionics, in the uncongested blue Goan skies.

A Blue Fox air-interception (AI) involved tracking the target on a 6x9-inch display, using a tracker ball, while talking to London Military Control, switching IFF codes, flipping R/T channels and flying the jump-jet through fairly intense air traffic. Successful accomplishment of half a dozen AIs on a pitch-dark night with 7/8 clouding did not warrant any celebration. Because you then had to join up with the leader for a section-GCA, ending in a night vertical landing! The mid-night beer in the crew-room thereafter certainly tasted sweet!

The Squadron's 22nd anniversary was celebrated in traditional White Tiger style, with a *bara khana* followed by a variety entertainment show. Our RN invitees had a good tuck-in. The Tigers had a great bash in the HMS *Heron* wardroom where Captain BD Law, the first Tiger Boss, was our chief guest.

Using just two fighters, and borrowed RN trainers, we managed to finish day and night AIs, as well as air-to-ground armament work at the nearby Pembrey firing range. We learnt the simple joys of the Yeovilton ski-jump, before spending a day on board HMS *Hermes* (later INS *Viraat*) off Portland Bill to earn our deck landing qualifications. Air-to-air gunnery on a banner and air-combat rounded off the syllabus and No. 1 OFT had finished by end-November.

Our technical officers and men had applied themselves to training with great dedication, and surprised the RN with their quick grasp of maintenance issues

and problems. They progressively took over the squadron's maintenance tasks and the timely completion of the OFT owed a great deal to their diligence.

The Homebound Ferry

After a great deal of debate and discussion we managed to convince everyone that the first three aircraft should be ferried by the squadron to India and it was decided that Sanjoy Gupta, Taylor Scott (of BAe) and I would fly IN 603, 604 and 605 from Yeovilton to Dabolim in mid-December. Monstrous 330-gallon ferry-tanks were slapped onto the aircraft, flight plans were flashed to Luqa (Malta), Luxor (Egypt), Dubai (UAE) and Dabolim, and on the cold, frosty morning of 13 December 1983 we taxied out for the ferry.

The combination of Blue Fox and NAVHARS (Navigation Heading and Altitude Reference System) helped tremendously in navigating across the Mediterranean and North Africa. Except for an approaching sandstorm (*Khamsin*) in Luxor, which we avoided with a hurried departure, the ferry remained uneventful. At every halt, we needed a couple of hours for refuelling, post-flight servicing and fitting aircraft covers before we could retire to the hotel. While crossing Saudi Arabian airspace we were directed by an AWACS on patrol, with occasional F-15s dropping by to have a look.

The final Dubai-Dabolim leg was about 1,400 nm, almost all of it over the sea. We fervently hoped that the NAVHARS wouldn't let us down during the two-and-a-half hour trans-ocean flight without updates. NHQ had thoughtfully positioned a SAR destroyer (commanded by Captain PS Das) en-route, but forgot to inform us ! The navigation kit, however, performed well and we picked up Marmagao Head on the Blue Fox at about 120 nm – more or less on the nose.

Overhead Dabolim, on 16 December 1983, we were welcomed by Ulhas Bapat, in Sea Hawk IN 238, which joined our formation. This was the last flight of an IN Sea Hawk. On the ground, the CNS Admiral Dawson was present to receive us along with the Vice Chief VAdm Tahiliani (see photograph on left).

The old order had given way to the new, and the re-incarnated White Tigers were on the prowl again.

Down to Earth and On to Mother!

Jet lag having receded, two days later we came down from *vilayat* (abroad) to mother earth with a bang! To our horror we learnt from ATC that the temperature at Dabolim was 33 Celsius, about 18 degrees higher than Yeovilton! There were some ashen faces as we worked out the meagre hover fuel-weights and realised that we would need to land within 60-90 seconds of establishing hover.

On 21 December 1983, Sanjoy Gupta and I landed on board INS *Vikrant* for aircraft trials and familiarisation for the ship's crew. While vertical landing was not such a problem, the short take-off turned out to be rather interesting. *Vikrant*'s steam catapult had been retained for Alize operations, and during launch the Sea Harrier's port outrigger rattled as it rode over the catapult track and shuttle. *Vikrant* did not (yet) have a ski-jump and exit from the flat deck was just 40 feet above sea level. If nozzle rotation was not smart, or the ship pitched down at launch, you suddenly saw water all around!

Starting light, we gingerly worked up to full all-up weight launches, and soon flat-deck operations from 'Mother' had become routine. The squadron technical

crew did a great job and the ship's FLYCO, flight deck, hangar, radar and CCA (Carrier Controlled Approach) teams learned quickly about V/STOL operations. We also had excellent support from the dedicated BAe and Rolls Royce resident reps, Graham Thomas and Steve Sage. Bending a few rules, the squadron also undertook electro-magnetic compatibility, and carriage and release trials of most weapons – depriving BAe of a few million pounds.

A Boost for the Fleet

Induction of the Sea Harrier brought with it not just a significant enhancement of defensive and offensive capabilities but also a quantum jump in technology for the IN. Its advanced avionics, weapon aiming computers and complex engine were all representative of 3rd generation state-of-the art.

At that juncture, the main threat to our carrier task-force emanated from Pakistan Navy Breguet Atlantique maritime patrol aircraft as well as PAF Mirage fighters, armed with Exocet anti-ship missiles. The fleet's air-defences being limited, it had to be deployed with due caution.

With its multi-mode Blue Fox radar and a weapon suite that included the Magic AAM and Sea Eagle anti-ship missile, the Sea Harrier ensured a large protective dome around the fleet against airborne and surface threats. Its radar and electronic-warfare suite also became the fleet's 'eyes in the sky.' For a Navy that had always worried about the outcome of a Sea Hawk encountering a PAF F-86 Sabre, the presence of the Sea Harrier in the fleet was a great morale-booster. It served to hugely expand the Fleet Commanders' options.

Two Landmarks

An unusual event that needs brief mention is the Sea Harrier's debut in the national capital in 1985. Eager to show off the Navy's new acquisition, Admiral Dawson had mooted Sea Harrier participation in

the Republic Day fly-past. Considered an IAF preserve, the MoD denied us entry into this event, but eventually allowed a brief display before the Beating the Retreat ceremony.

On 29 January, a 'vic' of three Sea Harriers made a high-speed pass down Raj Path, and after executing a 'bomb-burst' manoeuvre over Vijay Chowk, the Leader looped back to hover in front of the assembled dignitaries. (*The author is being modest; it was he who led this formation and conducted the historic hover at Vijay Chowk –Ed*) About 10,000 indignant pigeons emerged from the ancient domes of North and South Blocks to protest!

Soon after, Admiral Tahiliani took over as CNS, and we started receiving queries about night operations from *Vikrant*. I advised caution because of: (a) the lack of any night-landing aids on Vikrant; (b) the flat deck exit at 40 feet (the ski-jump came later); and (c) our limited flying experience. But Admiral Tahiliani was a resolute man. In early April 1985, Sanjoy and I landed on board on a dark night. There were some hair-raising moments but we were happy enough to launch and recover once again that night, and on two subsequent nights. On board, waiting to shake our hands, was Admiral Tahiliani himself !

End Game

In 2005, somewhat belatedly, NHQ implemented a Limited Upgrade of the Sea Harriers (LUSH), which equipped the aircraft with the new Israeli Elta EL/M-2032 radar, advanced Derby AAM, Elbit DASH helmet sight, and an air-to-air data link. This gave the aircraft a fresh operational edge over most potential adversaries, as proven in exercises with the IAF and foreign navies.

LUSH was to have an unfortunate consequence — the upgrade was undertaken by an Israeli firm, in collaboration with HAL, and the aircraft manufacturer was left out, BAe progressively diminishing its support to IN Sea Harriers. The writing on the wall became clear: the Jump Jet's days were numbered. But our maintainers and logisticians, through ingenuity and hard labour, managed to stretch out its life by yet another decade!

In early 2016, a decision was taken to withdraw the Sea Harrier from service. By now INAS 303, the new MiG-29K squadron was already serving on board INS *Vikramaditya*. To many, it seemed that the withdrawal of the Sea Harrier would also mean the end of the road for INAS 300, the fabled White Tigers of Bangladesh Liberation War fame. Fortunately, NHQ decided otherwise.

Adieu Jump Jet

On 11 May 2016, the CNS, Admiral Robin Dhowan (White Tiger, vintage 1982), presided over a brief ceremony at Dabolim, in which INAS 300 bid adieu to the Sea Harrier and inducted the MiG-29K as replacement. A pair of Sea Harriers, followed by two MiG-29KUBs got airborne; one section led by the current CO and the other by the CO Designate. After a brief but impressive display of their respective capabilities, both sections taxied in and a ceremonial change of command took place.

The unique 'Jump Jet' doubtless made an extraordinary contribution to our maritime capability for 33 years. But even the most proud and misty-eyed old White Tiger would acknowledge that the MiG-29K was a generation ahead in performance. Operating from a big-deck carrier like *Vikramaditya* the new INAS 300 will enable the IN to look every other Navy—and many Air Forces—square in the eyes.

As the old order changeth, we bid adieu to the beloved Sea Harrier… and welcome the MiG-29K !

Then-CNS Admiral RK Dhowan unveils a plaque commemorating the transition from Sea Harriers to MiG-29Ks at INAS 300. From left to right are: R Adm PK Nahl, FOGA/FONA, Cdr Shikku Raj Pillai, the outgoing INAS 300 CO, Capt KHV Singh, the new Squadron CO, and V Adm Sunil Lanba, then FOC-in-C WNC and now CNS (photo: Angad Singh)

"The old order changeth – again"

Sharper Claws for the White Tigers

The Navy's new Operational Training Unit

The former and present COs of INAS 300 in front of the Squadron's former and present aircraft

As reported in the previous issue of *Vayu* (*III/2016*), when Cdr Shikku Raj Pillai formally handed over command of INAS 300 to Capt KHV Singh on 11 May 2016 at INS *Hansa*, the V/STOL era in India came to an end. All INAS 300 Sea Harrier pilots (six at the time) have moved on to non-aviation posts, some permanently and others only for a short while before they rejoin the flying stream — either as much-needed Qualified Flying Instructors (QFIs) with INAS 551 'Phantoms' flying BAE Hawk Mk.132s out of INS *Dega* at Visakhapatnam, or converting to the MiG-29K.

The Sea Harriers' ageing 'mother,' the aircraft carrier INS *Viraat* (ex-HMS *Hermes*) has not yet been formally decommissioned, but is presently docked at Mumbai and unlikely to sail again before she is formally seen off later this year. The Navy hopes that both *Viraat* and her Sea Harriers will be preserved rather than scrapped. For the carrier the Navy is soliciting bids from India's coastal states that will outline their willingness and ability to maintain the vessel in a suitable state, in order to avoid the regrettable situation that arose with the INS *Vikrant* museum in Mumbai. The Sea Harriers on the other hand will be preserved around the country at various Naval Stations and institutions. Any additional aircraft available may find their way to any interested non-Navy homes, such as HAL's museum in Bangalore. The DPSU had a hand in the type's mid-life upgrade and is understood to be keen to acquire an example.

The White Tigers now fly MiG-29K/KUB STOBAR fighters, and will serve as the Navy's Operational Training Unit (OTU) for the type.

Operational Training

While INAS 551 'Phantoms' is the unit that lays the groundwork for all Indian Navy fighter pilots, the operational conversion to Sea Harriers was done at INAS 552 (formerly 551B) 'Braves,' co-located with INAS 300 at INS *Hansa*, Goa. The 'Braves' graduated the last batch of Sea Harrier pilots in 2014, before being folded into INAS 300 in October that year, with Cdr Shikku Raj Pillai, then-CO of INAS 552, taking charge of the White Tigers.

In the meantime, MiG-29K conversion was happening within INAS 303 'Black Panthers' itself, as the unit awaited arrival of the refurbished STOBAR carrier INS *Vikramaditya* (ex-*Admiral Gorshkov*). With *Vikramaditya* having worked up to 'fully ops' status and INAS 303 conducting operational flying from her deck, a need was felt to replicate the Sea-Harrier-style training pipeline and establish a dedicated operational training unit for the new STOBAR fighters.

A new MiG-29K training unit, INAS 553, was mooted, with the provisional nickname 'Fighting Lions'. The group began operating as a 'cell' within the Navy's aviation branch, with plans to be formally commissioned around mid-2016. However, with the impending exit of the Sea Harriers approaching, the Navy elected earlier this year not to 'numberplate' the iconic INAS 300, and instead simply transferred the operational training role, along with the personnel of the INAS 553 cell, to the White Tigers.

The transition has seen around a third of INAS 300's technical personnel move to INAS 551 at INS *Dega*, where they will work on the unit's BAE Hawk Mk.132s. They will be replaced by INAS 553 staff, which is already trained on the MiG-29K/KUB, while the remainder of INAS 300's staff will begin the conversion process to the new type. All flying personnel in the unit are new, with the senior pilots drawn from INAS 303 and the trainees from INAS 551.

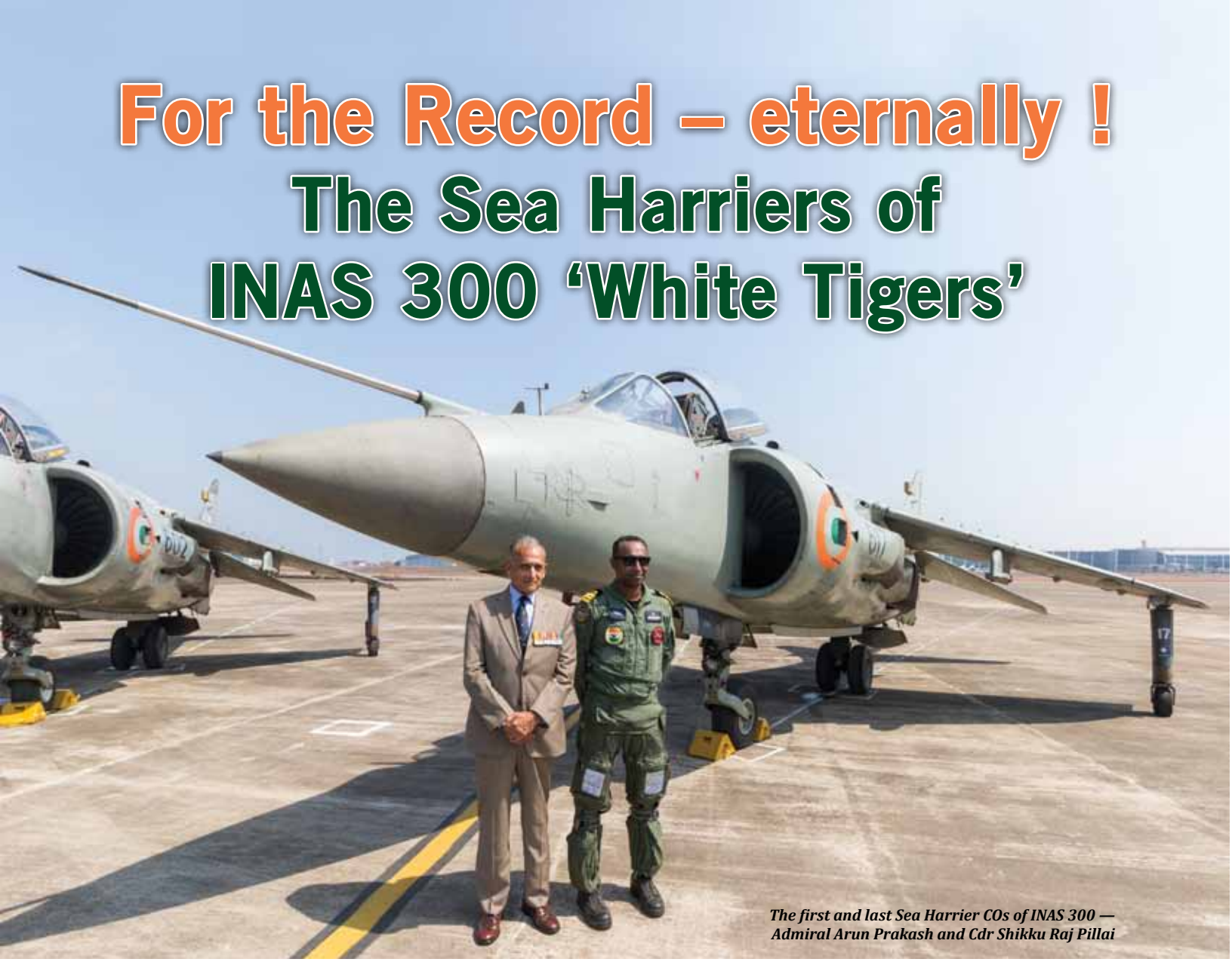
INAS 300 will now convert Naval Aviators from the Hawk to the MiG-29K, see them through their first solos on the type, all the way through to their carrier qualifications. When pilots are 'day ops' on the carrier – qualified to conduct daytime/good weather air defence operations from deck – they will move to INAS 303 and begin operational flying, picking up more qualifications (night, strike, and so on) along the way.

Eventually, some three-odd years from now, INAS 300 will form the nucleus of the air wing for India's second aircraft carrier, INS *Vikrant*, currently under construction at Cochin. When INAS 300 transitions to the operational role and is formally assigned to the carrier, the Navy will stand up a new training unit, with the correct numbering convention. It is unclear, but certainly very likely, that this unit will then be called INAS 553.

Text and photos: Angad Singh

For the Record – eternally !

The Sea Harriers of INAS 300 'White Tigers'



The first and last Sea Harrier COs of INAS 300 — Admiral Arun Prakash and Cdr Shikku Raj Pillai

Lt Cdr S Patil landing at INS Hansa on 10 May, and becoming the final IN Sea Harrier pilot to pass 500 hours on type

Lt Cdr Gokul Suresh taxis his Sea Harrier through the water cannon salute after his final vertical landing

On 11 May 2016, all Sea Harriers at INS Hansa bore commemorative '1983-2016' text on their tails, highlighting the type's 33 years of service with the Indian Navy

'Home is the sailor...' *
Head-on with a Sea Harrier returning to the INAS 300 apron at Dabolim

** Home is the sailor, home from sea, and the hunter, home from the hill*
[RL Stevenson]

Photos: Angad Singh

INAS 300 Senior Pilot Lt Cdr Gokul Suresh powering skyward in a short take-off

INS *Viraat* sails for the last time

The Indian Navy's iconic STOVL carrier INS *Viraat* set sail for the last time from Mumbai on 23 July 2016, escorted out of harbour by Fast Interceptor Craft and helicopters from Western Naval Command. The carrier will undergo 'Essential Repairs and Dry Docking' (ERDD) at Kochi, where all operational and sensitive hardware will be removed from the ship to prepare it for de-commissioning. *Viraat* will then be towed back to Mumbai for a proper farewell ceremony later this year.

(photo: Indian Navy)

Non Stop Innovation !

Vayu at Airbus Innovation Days 2016

World media in front of the famous ship propeller outside the Maritime Museum in Hafencity, Hamburg

This time around there were 150 attendees from all over the world, more than twice as many as in 2015, *(see Vayu Issue IV/2015)*. However, there was a change in scene: instead of Toulouse in southwestern France, it was Hamburg on the River Elbe, in northern Germany. The setting was dramatic, with massive ships docking next to the Airbus facilities at Finkenwerder, alongside the dedicated airport where gargantuan Airbus Beluga transports regularly took off or landed with their cabins loaded with aircraft fuselage structures and wings, transported to the final assembly plant in Toulouse. The Airbus Beluga has supplanted the earlier Super Guppies which pioneered this unique operation while the Beluga XL, based on the A330 will transport two A350 wings apiece, with first aircraft certification and entry into service planned for mid-2019.

This professionally planned and meticulously conducted programme for over two days, included factory visits at Finkenwerder and 40 km away at Stade. True to Airbus hospitality, the visitors were first welcomed to dinner at the Rilano Hotel by Klaus Richter, Chief Procurement Officer Airbus Group & Airbus and Chairman of the Board of Management of Airbus in Germany on 29 May and the next day, after a swish boat ride along the busy Hamburg harbour, to a formal dinner reception at the Elbarkaden, hosted by John Leahy, Chief Operating Officer, Customers.

Stepping up !

Lest the reader feel there was all play and no work, read on ! The programme was intense, with all assembled exactly on time at the Airbus facilities in Finkenwerder on 30 May morning, to be briefed on the sequence of presentations by Stefan Schaffrath, VP Media Relations.

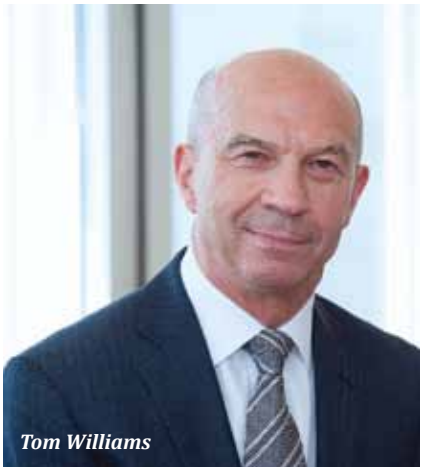
Opening the innings (appropriately) was Tom Williams, the Chief Operating Officer who has taken over this awesome responsibility from Guenter Butschek, with a brief on the production programme : Airbus 'enjoys' an immense order book of just under 7000 aircraft and at present some 40 Airbus airliners are delivered each month from the assembly lines at Toulouse, Hamburg, Tianjin in China and Mobile, Alabama (USA). "The challenge is to take this upto 50 a month next year and 60 in 2019".

In his characteristic accent (he was earlier with BAE Systems at Warton) Tom recalled how Airbus has prepared to meet the demand : "Ten years ago we talked about a rate of 20 aircraft per month. People came to us saying, 'Impossible, it's beyond the laws of physics, the supply chain will not stand it'. But, quoting Tom from an earlier interview, "this is not rocket science – it's very detailed work in the supply chain. We make sure the supply chain can take it … we do that by giving suppliers a long perspective. In what other industry can I tell which aeroplane I'm going to build in three year's time. It's exceptional"!

Production of Airbus airliners is being ramped up to 60 aircraft a month !

Tom Williams, also affectionately known as 'Airbus's Mr Fixit', is an expert at finding and correcting hiccups in the supply chain, where not only small components can hold up deliveries (such as Zodiac's repeated failures) but even delays in power plants can result in a number of 'gliders' parked at the delivery airport !

As he famously said "If someone said we can't build the aeroplane because of the engine or the radar, some hi-tech product, I wouldn't be sympathetic, but I could understand", but not if it is the "toilet mirror or seat armrest caps"!



Tom Williams

Production of A350-1000

The challenge certainly is to ramp up production of the world's best selling narrow body airliner, the A320neo from the present 40 or so to 60 per month by 2019, boosting production in 'faster, smarter and more innovative' approaches and as Airbus accurately state, "the sun never sets on Airbus A320 production"! Meanwhile production rate of the A350XWB is gradually increasing so that by end 2016, 50 of this new generation 'extra wide body' airliner would be delivered. Prospects for the future A350-1000 are even more exciting !

Amongst the new smart production techniques are modular electrical drilling units, smart glasses, and exoskeleton devices while drones carry out external checks, such collaborative means lifting production to new heights.

Following Tom, it was the turn of Didier Evrard, Executive Vice President Programmes who focussed on the four

areas of concentration for Airbus : *ramping up of A320 production; ramping up of A350 production; transition to A330neo* and *keeping the A380 programme airborne*. All programmes are on track, with more than 40 A350 XWBs in final assembly with the first A350-1000 delivery planned in the second half of 2017 : "a new chapter in innovation which will shape the future". The imperative of having the right environment for passengers is well recognised to ensure highest level of quality and customer loyalty.

A perfectly timed announcement was on Cathay Pacific Airways becoming the sixth airline to operate the A350-900 which is part of their order for 48 aircraft, including 22 A350-900s and 26 of the larger A350-1000s. The A350-900 ultra long range airline will enable SIA to resume 19 hour, non-stop flights from Singapore to New York.

'Worlds best selling airliner'

Klaus Roewe, head of the A320 family programme, was euphoric about the world's best selling airliner – with its unbeatable fuel efficiency – now operated by 82 airlines. The A320neo meanwhile has 4515 firm orders from 82 customers, taking a 60% market share and incorporating "innovation where it matters". Having 95% airframe spares commonality with the A320, the lower operating costs include 15% reduction in fuel burn, with higher range, better low speed performance and shorter time to climb. On ground, the A320neo has 50% reduction in noise footprint, something already being experienced in India with IndiGo, second in the world (after Lufthansa) to induct the A320neo shortly followed by GoAir in June (*see item in this Issue*).


Klaus Roewe

The theme of 'Non-Stop Innovation' continued with Didier Lux, Head of Customer Services, talking about the expansion in Airbus Global footprint with "more proximity to support customers 24/7". There are over 5,500 personnel deployed worldwide, the Airbus footprint including a Flight Training Centre in India. Meanwhile, Delta Airlines has become launch customer of Airbus' digital Prognostics and Risk-Management solution.

"An amazing airliner !"

Yes, John Leahy, Chief Operating Officer – Customers, was exulting about the A320neo which has just gone into service, first off with Lufthansa and shortly thereafter, with IndiGo. The A320neo has tremendous attributes, with 16-17% lower fuel burn per seat and as the jingle goes, "less noise, less fuel, less CO_2". The A320 family has been at the leading edge of Airbus successes, and as John Leahy stated, "an A320 takes off or lands every 2 seconds in the world." Of the total orders for 12,499 aircraft of this family, some 7,020 have been delivered, "undisputed market leader" with 79% of the market share ("probably the most efficient airliner in the world").

The long range A321LR, with its 4,000nm range, has a potential market of 1000 aircraft, giving airline planners flexibility to operate completely new sectors including India-Eastern Europe, West Africa-Europe Australia-South East Asia and Europe-Central Asia.

Not far off is the A330neo, which with its aerodynamic improvements including increased span wings and sharklets, and new generation engines, will still have 95% space commonality with the A330, regarded as the world's best selling wide body airliner of which 1,634 numbers have been ordered, 'a very impressive aeroplane' whose new

'Airspace interiors' of the A321neo will give it a common look and feeling with that of the A350WB. Some 804 of the latter have been ordered with 24 delivered at the time of *Vayu*'s briefing. According to Lufthansa, Delhi will be first destination within the Lufthansa network to be served with a new Airbus A350 at the beginning of 2017.

One of the first airlines to order the A320XWB and start services was Finnair whose CEO Pekka Vauramo is most outspoken about their excellent experience with the type. Meanwhile the A350-ULR is being developed with Singapore Airlines as its champion, this ultra long range airliner "strategically very important" to SIA with its 8,700 nm range for non-stop premium routes. Meanwhile, development of the A350-1000 is on track, with 181 orders received from 10 customers and entry into service planned for 2017. In his no-holds

The Airbus 'Air Space' approach is seen in this A330neo mock up at AIX 2016 in Hamburg

barred presentation, John Leahy took on its direct competitor, Boeing's 777-300ER over which the new Airbus type "has cost/seat and range advantages."

"Last but not the least" is the mega A380 and here John was more circumspect. Of 47 'mega cities' in the world of air traffic, 36 are already served by A380s, with 50 daily flights at Heathrow alone. Other major A380 destinations are Hong Kong and Los Angeles, the latter with 24 daily flights from Seoul, Tokyo, Guangzhou, Sydney, Melbourne, London, Frankfurt, Paris and Dubai.

As this is written, news comes in that slot-constrained Santa Cruz airport in Mumbai is fast becoming a magnet for the Airbus A380, with Lufthansa planning to deploy this aircraft on the Mumbai-Frankfurt route from next summer. Currently, three international airlines — Singapore Airlines (SIA), Emirates, and Etihad — fly this mega airliner to Mumbai, while Delhi is also served by A380s from SIA and Lufthansa.

The phenomenal market demand is exceeding earlier forecasts, with worldwide passenger traffic up 5.9%, outperforming GDP growth, even as air travel overcomes external shocks including the oil crisis, Gulf crisis and recent financial crisis. Millions of middle class people have become frequent air travelers, this growth driven by airlines in the Asia-Pacific region.

A320neo with CFM LEAP-1A in joint EASA/FAA certification

The A320neo powered by CFM International's LEAP-1A engine has received Type Certification from the European Aviation Safety Agency (EASA) and the U.S. Federal Aviation Administration (FAA), paving the way for delivery of the first A320neo equipped with the LEAP engine in mid-2016. Airbus selected the LEAP-1A as an option for the A320neo in December 2010, the engine flying for the first time on the A320neo on 19 May 2015. Overall, CFM LEAP-engined A320neos have accumulated more than 1,000 flight hours in more than 350 flights, including 150 flight hours completed with the same aircraft in an airline-like environment to ensure operational maturity at entry into service. In February, the LEAP-1A became the first engine to power the A321neo, currently undergoing flight tests.

A380 making its mark

"The Airbus A380 is making its mark on the world's busiest hubs – opening up new opportunities for these airports, as well as their passengers and airlines – with the aircraft's 'unmatched spaciousness, efficiency and comfort." Currently operating at some 50 destinations, the double-deck, 544-seat-capacity A380 is helping airports across the globe boost capacity, attract more passengers, increase revenue, free up slots at their gates, and reduce landing fees – benefits for both airlines and travellers. Capacity-constrained major international travel hubs such as London's Heathrow and Hong Kong International Airport operate many scheduled A380 flights daily, and have seen the enormous benefits of this Airbus 21st century flagship jetliner. In addition to the world's busiest airports, fast-developing air transportation markets are also positioned to benefit from the A380. Airbus' Executive Vice President of Marketing and Strategy Kiran Rao cites the example of India, with an emerging middle class that is expected to exceed 400 million people in the coming years. "The only way to move all those passengers around is on a large aircraft and you have to do so with economic efficiency and with comfort, and the A380 is the solution.

An Emirates A380 at the recently concluded Berlin Airshow 2016

The Airbus 'Joint family' product line

The family in India does not consist only of the husband, wife and their children but also of uncles, aunts and cousins and grandsons. This system, called joint family or extended family system is a peculiar characteristic of the Indian social life. So what is the connection between India's social structure and the Airbus family?


Dr Kiran Rao

Actually, it was particularly apt that the presentation on Airbus's 'most comprehensive product line' was made by Dr Kiran Rao, Executive Vice President – Strategy & Marketing with his Indian roots, one who had grown up in Bangalore, India's 'aerospace capital' where, too, Airbus have extensive activity including the ongoing production of A320 forward passenger doors at HAL's Bangalore Complex. Airbus' list of Indian partners and suppliers has expanded to encompass engineering, IT services, technical publications, research and technology and manufacturing of aero-structures, detail parts and sub-assemblies. More than 5,000 professionals throughout India contribute directly or otherwise to various Airbus aircraft programmes.

Dr Rao had studied Aeronautical Engineering in London, with a PhD in transonic aerodynamics and then worked on flight control systems. He joined Airbus in December 1992 as Airline Marketing Manager and since then there has been no looking back, being promoted to Vice President of Sales for South Asia and Africa, then Senior Vice President Marketing & Pricing Policies before being appointed as EVP Strategy and Future Programmes in November 2012.

As Dr Rao explained, the key to Airbus strategy, is its 'family' of airliners which encompass a complete, far sighted product line "designed for comfort, efficiency and profitability". The uniqueness of the A320, for instance, is that this family of 3 sizes, from 140 to 240 seats, "is well spaced and protects each other's value". Passengers will revel in the A320neo which boasts of the widest single aisle cabin in the sky, the increased cabin efficiency offering a modular approach ('space-flex') with the innovative LED Mood lighting offering an incredible 16.7 million colours.

Moving on the wide bodies, Dr Kiran Rao explained the trajectory or strategy for the A330 which is for it to go 'neo' too, with "unbeatable comfort and economics". The A330neo cabin will replicate the A350XWB style as also "attributes of efficiency, quietness and comfort". In fact, the A330neo space optimisation design results in a gain of 10 seats "without compromising comfort", this "quietest cabin in its class" giving a sense of well being. Dr Rao extolled the A350XWB as being "the leading edge of Airbus innovation, whose continuous incremental development would turn innovation into higher aircraft value".

IndiGo have a considerable fleet of A320s, with 400 more on order

The new "Airspace by Airbus" cabin concept

An innovative new concept in jetliner cabins has been launched with the 'Airspace by Airbus' brand, bringing together an enhanced experience for passengers and optimum performance for airlines based on four dimensions: comfort, ambience, service and design. Introduced with Airbus' widebody A330neo (new engine option) version, and incorporated on the A350 XWB, Airspace cabins offer a more relaxing, inspiring, attractive and functional environment for travellers and optimises the use of cabin space for operators.

"The A380 already offers the best comfort of any aircraft, and the A320 is the top in its single-aisle category," explained Kiran Rao, Executive Vice President of Marketing & Strategy. "Airspace is another step forward, reflecting our decision to bring consistency on our two best-selling widebody aircraft: the A350 XWB and A330neo."

The A330neo will soon traverse global skies

Cathay Pacific are a new operator of A350XWB

His last word was on the "undisputed" industry flagship, the A380 "which too has been subject of nonstop innovation since entry into service and the possibility of an A380neo coming about is inevitable." This mega airliner will be around for next 30-40 years and answering specific questions, "yes, there is a second hand market for A380s" as early delivered aircraft to SIA or Emirates become available.

FAA approves A350 XWB for 'beyond 180 minutes' ETOPS

The US Federal Aviation Administration (FAA) has approved the Airbus A350-900 for ETOPS (Extended-range Twin engine aircraft Operations) 'beyond 180 minutes' diversion time. This approval means that when the first FAA-affiliated operators start to take delivery of their A350s in 2017 they will be able to serve new direct non-limiting routings, compared with a standard 180 minute ETOPS diversion time. It also means that now the A350 XWB is approved by both EASA and the FAA for beyond 180 minutes ETOPS.

"The A380 already offers the best comfort of any aircraft, and the A320 is the top in its single-aisle category," explained Kiran Rao, Executive Vice President of Marketing & Strategy. "Airspace is another step forward, reflecting our decision to bring consistency on our two best-selling widebody aircraft: the A350 XWB and A330neo."

Digital Transformation

Continuing the theme of 'nonstop innovation' was Marc Fontaine, who heads the Digital Transformation Office of the Airbus Group and explained how the world is changing and Airbus is embracing digital transformation, the pace of disruption being higher than ever as "we face massive opportunities for more speed, agility and efficiency". This sounded familiar to Indian ears with Prime Minister Modi having launched the Digital India campaign in July 2015 to make services available to citizens electronically by improving online infrastructure and by increasing Internet connectivity, thus making the country digitally empowered in the field of technology.

The penultimate presentations, on "how Airbus designs the future" were led by Charles Champion, Executive Vice President, Engineering, who explained how the Group leverages incremental and breakthrough innovations in designing its future aircraft. An innovative way to enhance aircraft performance is by application of riblets which reduce turbulent drag in cruise, its expected benefits including a 1.5% decrease in fuel burn.

Airbus have programmes to co-innovate with universities in over 100 countries worldwide, with 15,000 students registered. "Airbus Fly-Your-Ideas is a unique global student competition, designed to establish a strong and lasting relationship between Airbus and the next generation of innovators. Every two years, the competition offers a unique opportunity for students from across the globe to co-innovate the Airbus on real challenges facing the aviation industry and to develop valuable skills for their future careers". It was pleasing to see the global map with a massive cluster of dots indicating such involvement in India.

Charles Champion

The future Airbus ?

Airbus and India

And then it was time for Fabrice Brégier who took the stage, facing the 150 international media who were raring to ask many bottled up questions after two days of virtual one-way traffic. The President and Chief Executive Officer (CEO) of Airbus certainly faced all that was shot at him with aplomb. Appointed President/CEO on 1 June 2012, Fabrice Brégier is a member of the Airbus Group Executive Committee, having earlier been Airbus Chief Operating Officer (COO). As a Member of the EADS Executive Committee, he was commissioned by Louis Gallois "to improve overall operational performance of the Group," his responsibilities including the company's wide-ranging restructuring and change programme (Power8) – and significantly the A350 XWB programme.

India-specific questions posed by *Vayu* concerned the Group's ramping up of A320 production and whether the Group had considered increased supply chain involvement from India, also in context with Airbus expanding its activities in China. Ever the diplomat, Mr Brégier referred to the attraction of 'Making in India', accepting that there is enormous potential in India whose population is nearly equal to that of China, "but the flying population remains far less."

There are a total of 207 A320 family airliners already in service with four Indian operators and another 520 are on order, but on side lines of the presentation, Fabrice

Brégier felt that "too much bureaucracy is still a hindrance to realising the industry's potential". Taking the question head on when comparing India with China, he said what's missing in India is a "long-term plan". On the other hand, and referring to technical talent, he was very pleased with the Airbus design centre in Bengaluru "which is doing a great job. We now have big groups and companies ready to invest in manufacturing. I have given the example of Dynamatic Technologies (which makes flap track beams for Airbus' A320 and A330). Yes, things are moving. But two years is very short in Indian aerospace. It will take a bit longer, but I feel really strong, fresh air coming from the Indian government under Prime Minister Modi".

Mr Brégier had some clear views on wide-body airliners the employment of on Indian domestic routes. "We have been trying to promote the A330 regional in India. This will probably take a little more time. For instance, in China, from Shanghai to Beijing we have plenty of A330s flying. In India, the airlines first want to make money and then they will move to this next phase (of expansion). If you have too many rotations per day, what do you do? To transport more people you need bigger aircraft. But don't forget that we also offer the A321. IndiGo, for instance, is flying the A320 which can accommodate 180 passengers. If in the future, if they move to the A321s, they can carry 240 passengers".

The Airbus finger is obviously on the Indian pulse. Almost exactly a fortnight after the *Airbus Innovation Days 2016* programme in Hamburg, India's *National Civil Aviation Policy 2016* was formally released in New Delhi and it is pertinent to quote from the introductory paragraph :

"India has the potential to be among the global top three nations in terms of domestic and international passenger traffic. It has an ideal geographical location between the eastern and western hemisphere, a strong middle class of about 300 million Indians and a rapidly growing economy. Despite these advantages, the Indian aviation sector has not achieved the position it should have and at present it is ranked 10th in the world in terms of number of passengers".

The 'Vision' then expounds, which is "to create an eco-system to make flying affordable for the masses and to enable 300 million domestic ticketing by 2022 and 500 million by 2027, and international ticketing to increase to 200 million by 2027." As a direct comparison, in 2015 there were already over 300 million Chinese flying domestically.

A decade from now, when Airbus marks *Innovation Days 2027,* it will be fascinating to look back to present times and review how Indian Aviation met its stated objectives – and how much of that was supported from Toulouse and Hamburg.

Vistara have 20 A320s on order (including the neo) and with the new National Civil Aviation Policy announced, will undoubtedly vigorously expand its fleet and services

Air India fly the A321 on domestic routes

Taking a leaf from nature

Literally taking a leaf from nature, Peter Sander, Head of Emerging Technologies & Concepts enthralled those assembled with his presentation on this revolutionary technique, technically known as *Additive Layer Manufacturing* (ALM), a.k.a. 3D-printing. This innovative technology will arguably shape the future of aircraft component manufacturing and design. As an alternative to production processes such as milling, melting, casting and precision forging, it results in a mere 5% wastage of material instead of the staggering 95% from current machining *(Vayu was immdediately reminded of the Sukhoi Su-30MKI processes at HAL Nasik)*. Further, ALM allows for the first time the production of detailed, highly complex bionic parts, benefitting from natural designs with optimised load factors and more efficient use of resources.

Such pulverulent materials (consisting of fine particles) include aluminium, titanium, stainless steel or polyamides and, in production, these are typically built-up layer-by-layer followed by a computer-controlled laser beam which melts and fuses the tiny particles. Such technology enables the printing of any part with cavities, fins or integrated tubes.

3D-printed airworthiness certified parts are already flying on various Airbus aircraft, and include spare parts made of high performance plastics, or metal printed cabin brackets and fuel pipes on Airbus A350 XWB test aircraft. Additional parts and materials are currently in the certification process, and it is certain that this revolutionary manufacturing method will not only produce aircraft parts but also the production of jigs, tools, ground support equipment as well as spare parts.

Peter Sander, Head of Emerging Technologies & Concepts at Airbus

On display outside the Airbus Auditorium was THOR (Test of High-tech Objectives in Reality), scale model of a 3D-printed aircraft, the object of great interest to the visitors and later displayed at ILA 2016, the Berlin Air Show at Schoenefeld. The aircraft is windowless, weighs 21kg and is less than 13ft long, the only parts of which that are not printed from a substance called polyamide being the electrical elements. The small pilotless propeller aircraft is seen as a pioneer that is a vision of things to come: an aviation future when 3D printing technology promises to save time, fuel and money. The 3D-printed parts are 30-50% lighter and there is almost zero manufacturing waste, thus promising ecological benefits as lighter jets use less fuel and spew out fewer pollutants.

Peter Sander's talk was followed by Ralph Maurer's brief on direct printing technologies while Alexander Katzung was focused on Airbus BizLab, which supports the strategy of commercialising innovative ideas drawn from within Airbus and also externally. "The Airbus Bizlab is a global aerospace accelerator bringing together start-ups and Airbus' own entrepreneurs to transform innovative ideas into valuable businesses more quickly".

It was his reference to the Airbus 'Silicon Valley' which made Indian hearts pound a little more, with reference to the Toulouse-Hamburg-Bangalore link. "The first Airbus Bizlab was inaugurated on 9 March 2015 in Toulouse, France, the second centre inaugurated on 2 September, 2015 in Hamburg, Germany, followed by Bangalore's on 24 November 2015, all part of the Airbus strategy to create a global network of Airbus BizLabs".

This giant water lily (seen at the University of Kiel) has also helped aircraft designers in their endeavours to understand and copy nature for bionic design

First flight of the 3D printed aircraft, THOR

Visiting the Airbus Stade site

Smart facilities, smart production at Airbus Stade

Following the presentations at the Finkenweder site, was a brief visit to Stade. While the Airbus' Hamburg site manages structural assembly and outfitting of fuselage sections, as well as final assembly for A320 Family aircraft, the vertical tail planes of all Airbus aircraft are produced at Stade, some 40 kms away from Hamburg. This site also makes other carbon fibre reinforced plastic (CFRP) components, such as flaps for single-aisle A320 Family aircraft and spoilers for the A330. Pressure bulkheads for the A330 and A380 are part of Stade's production responsibilities. For the A350 XWB, this site produces the upper wing shell, along with the jetliner's vertical tail plane and CFRP fuselage shells.

Kai Arndt, head of Stade Plant was rightfully proud of the plant which is "home to Airbus' A380 major component assembly hall – which houses the structural assembly, equipping of the forward and complete rear fuselage sections, along with cabin furnishing, painting and delivery to customers in Europe and the Middle East".

Automated Fibre Placement on the A350 XWB

Awed by the A380 mega airliner

There are 1800 employees at the Stade facility

NEO vertical tailplane produced at Stade

First vertical tailplane for the A350-1000

The Stade Plant has specialised in composite parts and technologies since 1983. Double loading of the autoclave reduces process time by 50%

VAYU on-the-spot report

ILA Berlin Airshow 2016

Aerial view of the show (photos: ILA-Berlin press)

Innovation and Leadership in Aerospace

With numerous innovations and advanced technology on display, the ILA Berlin Air Show 2016 showcased the capabilities and achievements of the global aerospace industry. From 1 to 4 June 2016, a wide range of the latest hi-tech products as well as research and development projects were displayed by 1,017 exhibitors from 37 countries. During this four-day event, 150,000 trade visitors and members of the public visited the 250,000 square-metre Berlin ExpoCentre Airport. Some 200 aircraft were featured in the static and flying displays. For the professionals there were 50 congresses and conferences on the latest developments in the industry.

Digitalisation and 3D printing, Industry 4.0 and eco-efficiency were among the main themes addressed at the conferences. The many hi-tech products on view at the new Future Lab on the stand of the Federal Ministry of Economic Affairs provided insights into the technological future of the aerospace industry. *The Startup Day* was another new feature this year, and enabled 50 newly established companies to present their creative ideas and business models which have the potential to benefit the aerospace industry in the future.

As Volker Thum, Chief Executive of the German Aerospace Industries Association (BDLI) stated, "The past four days have clearly shown that ILA 2016 is synonymous with *Innovation and Leadership in Aerospace*. It dealt selectively with forward-looking topics in our outward looking industry, including sustainability, digitalisation, 3D printing and Industry 4.0. The past four days have given a significant impetus to these advanced areas, which our industry will be able to exploit in its efforts to implement innovative developments in cutting edge technology. I am particularly pleased with the entirely positive feedback from our exhibitors from all over the world. The wide and varied programme of flying displays provided impressive proof of the fascination exerted by our products".

At the Opening Ceremony: Sigmar Gabriel, Federal Minister for Economic Affairs and Energy, Germany (with Airbus A350WXB as the backdrop)

ILA 2016 was inaugurated by Federal Minister for Economics Sigmar Gabriel. Representing the German cabinet, Federal Defence Minister Dr Ursula von der Leyen and Federal Minister of Transport Alexander Dobrindt paid visits to the ILA. High-ranking delegations from Germany and around the world also attended the show, organised by the German Aerospace

Unusual sights in Western Europe: MiG-29 and Mil Mi-24 at ILA 2016

Industries Association (BDLI) and Messe Berlin GmbH.

Highlights of the flying display this year included the new Airbus flagship, the A350XWB, plus the A320neo, fitted with its new more environmentally friendly engines. The tanker and transport aircraft, the Airbus A330 MRTT, made its debut at this ILA. Visitors were able to inspect the world's two largest commercial aircraft, the Airbus A380 in Emirates livery, and a Boeing 747-8 from the Lufthansa fleet. While the Bluecopter from Airbus Helicopters represented a new generation of helicopters, one of the big attractions was provided by the demonstration flights of the Swiss national team; for many years *Patrouille Suisse* has been using the ILA for one of its rare foreign appearances. There were also breathtaking displays by individual aircraft: a German Air Force Eurofighter, a MiG-29 from the Polish Air Force and a Chinook heavy lift helicopter from Boeing. THOR from Airbus is the first aircraft to be produced almost entirely by 3D printing. Numerous unmanned aerial systems (UAS) for civilian and military use were also on show. Multicopters were deployed in the first Copter Race to be held at the show, in which these miniature remote-controlled aircraft flew around a course at speeds of up to 100 kilometres per hour.

The International Suppliers' Centre (ISC) was the ideal marketing platform for the entire supply industry – with a substantial increase in international involvement and the participation of many more leading decision-makers compared with the last ILA. One of the highlights was the Space Pavilion, which provided trade visitors and the public with graphic illustrations of the

An A400M being followed by the A350XWB before the flying display

MTU on the future of geared turbofans

Digitalisation and interconnection help to increase the pace of innovation, according to Reiner Winkler, chairman of the board of MTU Aero Engines, speaking at the ILA 2016. This engine manufacturer is concentrating on improving performance even further in its core areas of high pressure compressors and low pressure turbines. For the next 20 years the geared turbofan that has been developed jointly with Pratt & Whitney will remain the dominant power plant. Winkler reported that the initial software problems with the PW1100G for the Airbus A320neo were now resolved and the delay in introducing these engines had been reduced by means of a physical fix and software support. For the current year MTU expects sales of between 4.6 and 4.7 billion Euros, with a ten per cent profit margin.

benefits that space research offers mankind. The new HeliLounge was the main meeting place for the rotary wing sector.

In the mission pavilion the Bundeswehr and the military aircraft industry demonstrated the effective cooperation that ensures the operational capabilities of their aircraft. The German Aerospace Centre impressed trade visitors and the public alike with the majority of its fleet of research aircraft and details about its full range of research projects. During the two public days the ILA CareerCenter, Germany's largest aerospace job market, was the main attraction for young people with an interest in one of the many exciting careers in aviation and the space industry.

As the largest individual exhibitor at the ILA 2016, the German armed forces *(Bundeswehr)* presented their capabilities with a wide-ranging product display an outdoor display area covering more than 10,000 square metres. Aircraft included the Eurofighter and Tornado fighters, A400M, A310 MedEvac, A319, Transall C-160 transport aircraft, as well as CH-53, NH-90, Tiger, EC-135, Sea Lynx and Sea King helicopters.

Amongst international aircraft were the Polish Air Force MiG-29 and Sukhoi Su-22 as well as a Czech Air Force Saab JAS39 Gripen. The US Air Force displayed a Boeing C-17 Globemaster III, which US President Bill Clinton had christened 'The Spirit of Berlin', as well as a Lockheed Martin C-130J and a Rockwell B-1B bomber. On 4 June a USAF Boeing B-52, the iconic eight-engined, strategic bomber, performed a fly-past. The US Air Force and Royal Air Force showcased a CH-47 Chinook and AH-64 Apache helicopter respectively. Alongside, a Mi-35 attack helicopter was exhibited by the Czech Republic.

Market of the Future

ILA 2016 highlighted the market of the future with a UAS exhibition on the open-air grounds as well as with its own UAS displays in Hall 3. A total of around 40 exhibitors from 12 countries presented trends and innovative applications for UAS at the show. Flight displays included the Multicopter, Songbird 1400, D-AERO Zero and D-AERO One. The Bundeswehr was represented with several reconnaissance UAVs including a four-rotor MIKADO helicopter, a LUNA reconnaissance system, a tactical unmanned aerial system (TUAS), and an ALADIN reconnaissance UAS. The US Air Force exhibited its MQ-9 Reaper/Predator, a UAV built by General Atomics. Airbus Defence & Space exhibited a Heron TP, and the German manufacturer Reiner Stemme Utility Air Systems an unmanned single-engined Q01-100, a long-distance reconnaissance and surveillance aircraft.

Boeing celebrates centenary at ILA

Boeing celebrated the centenary of its founding at ILA 2016. The aircraft factory that was set up in 1916 in Washington state, USA, by the son of a German immigrant, Wilhelm Böing, is today the world's

The Airbus A400M with a Boeing 747 "Ed Force One" in the background

largest aerospace company. “Our airline customers in Germany, who are often the first to buy new Boeing models, together with our German suppliers, have made a significant contribution to this success”, according to Matthew W Ganz, President Boeing Germany & Northern Europe and Vice President European Technology Strategy. “The display by Boeing at the ILA 2016 focuses on the technologies produced for Boeing aircraft by German and European suppliers.” Numerous exhibitors were represented at the ILA with Boeing products, including Lufthansa with its “Fanhansa winners’ aircraft”, a Boeing 747-8, which was used to bring the Football World Cup winners from Rio to Berlin in 2014, and the US Air Force with, among others, a C-17 heavy military transport aircraft.

Boeing 747-830 "Siegerflieger Fanhansa"

"A tanker for every purpose": the A330 MRTT

The multi-purpose military Airbus A330 MRTT was on display for the first time at the ILA. Measuring almost 60 metres in length, this wide-body aircraft is has been developed from the successful A330 passenger aircraft. As an airborne tanker it can increase the range of combat aircraft, or alternatively, can be used to carry passengers or freight, or as a flying hospital. From Central Europe its maximum range of 14,800 kilometres puts almost all the inhabited regions of the earth within reach. Forty nine orders have been placed for the A330 MRTT, all of which were delivered by April 27. It is in service with the air forces of Australia, Saudi Arabia, the United Arab Emirates, the United Kingdom, France and South Korea. Singapore has also placed orders for this unique aircraft.

A400M and H145M on Static Display

As the largest exhibitor at ILA 2016 the Bundeswehr also exhibited the most aircraft, as well as drones, medical assistance and information stands. In addition to a MedEvac air ambulance and a Tornado that visitors could “feel and touch”, an A400M transport aircraft was also on display. Among the nine different helicopters on display was an H145M, a highly specialised utility helicopter that is equipped to meet commando forces’ special requirements.

Airbus Helicopters H145

Two Royal Navy AgustaWestland Wildcat helicopters painted in black and grey were among the special attractions of the flying displays at ILA 2016. The primary role of these helicopters is search and rescue missions and submarine warfare

The Antonov An-178 as a Transall replacement ?

A new tactical transport aircraft, the An-178 from the Ukrainian manufacturer Antonov, was demonstrated in flight for the first time at ILA 2016. Since its maiden flight just over one year ago the prototype has completed some 50 hours of trials. "The Ukrainian people are proud of this modern aircraft, which has been produced despite the most difficult economic and political conditions", stated Olena Zheliazo, responsible for Antonov's marketing. "It fills an important niche which competitors in the East are also keen to serve, although so far they have only been able to submit projects on paper. Our aircraft is already flying and is demonstrating its outstanding capabilities." Applying the modular principle, in recent years Antonov's engineers have used the An-72/74 freighter to develop the An-148 and -158 regional aircraft, and now the An-178 freighter. A year ago the Chief Designer Dmytro Kiva stated that, with its payload of 18 tonnes, the An-178 would be an 'ideal replacement for the Transall in Germany', and, with a wingspan of just under 30 metres this aircraft really "does fit perfectly in this performance category."

New ADS from MBDA and Rheinmetall

MBDA Deutschland, together with its industrial partner Rheinmetall, exhibited a system concept for close- and very close-range protection against airborne threats. This solution ensures highly mobile escort protection as well as immediate firing readiness and integrates seamlessly within the TLVS system architecture as a further possible element of integrated air defence. MBDA and Rheinmetall are pursuing a completely modular solution approach that leverages the integration of existing, series-ready subsystems and components, such as MBDA's Mistral guided missile integrated in the Rheinmetall MPCS turret.

2016

EUROSATORY

JUNE IN PARIS

The 25th Eurosatory land, air-land defence and security show organised by the French federation of industries in those sectors, GICAT, and its exhibition subsidiary COGES, confirmed its position as arguably the world's leading defence show with continuing rise in companies exhibiting at the event: 1,571, up from 1,504 in 2014. The show was in fact, dominated by non-French companies: of the 1,571 exhibitors, only 560 were French. The USA formed the largest non-French contingent, with 139 companies making the transatlantic trip. Close on its heels were 114 German companies, followed by the UK (80), Israel (51), Italy (47) and Austria (40).

Some companies opted to gather together under a national pavilion: this edition had 36 of them, clearly marked by hanging banners. Together, with all the other exhibitors, they showcased more than 600 pieces of major equipment and revealing more than 450 new products, which were viewed by 57,000 or so professional visitors, over 1000 media persons and 214 official delegations from 94 countries.

Trends in 2016 included unmanned systems and civil security and emergencies. The French Army and Defence Ministry had back-to-back stands in Hall 5. They focussed their exhibits on the Scorpion programme to modernise the French army with, notably, the Griffon and Jaguar vehicles, but also the new-generation Leclerc main battle tank.

BAE Systems had displays inside the halls as well as outdoor displays

There was 94,260m² of indoor space and 50,000m² of outdoor space; one could sit in the grandstand and watch the 50-minute dynamic demonstrations that took place twice a day or attend some of the 80 or so conferences that took place over course of the event.

Norway at Eurosatory : the Nammo stand at the Show

Some Highlights

Thales launches Ground Master 60

Thales launched its Ground Master 60 which is the 'only multi-mission radar capable of detecting all types of targets while on-the-move'. Owing to its compact design,

Ground Master 60

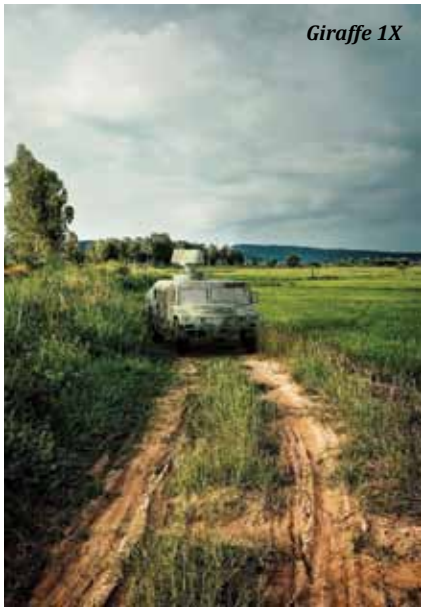
it is "perfectly adapted" for operational deployment on a vehicle. The Ground Master 60 provides projected forces with better situational awareness of the air picture, thereby giving them increased protection during their missions. In addition to its 'excellent' detection capacity while on-the-move, the Ground Master 60 can detect rockets, artillery shells and mortars to effectively complete the protection of deployed forces. An "all-in-one" radar, the Ground Master 60 is equipped with both a generator and an air conditioning system; key factors in ensuring high reliability and increased mobility. The radar can also be installed and removed very quickly in an operation theatre.


Thales' product displays at Eurosatory '16

Saab's Giraffe 1X, AT4 Roquette NG, Carl-Gustaf M4 and NLAW

Saab presented the mounted Giraffe 1X antenna for the first time at Eurosatory 2016 as part of a very short-range (VSHORAD) solution. The lightweight, compact Giraffe 1X can be handled by one single operator. Providing reliable protection for the forces and assets is even more important in high-risk situations, which requires a flexible and agile radar located close to the combat area. Saab's Giraffe 1X is lightweight, with a total weight of less than 200 kg and designed for easy integration which means that the complete radar can be transported on a pickup truck-sized vehicle, a helicopter or towed on a trailer. Its flexibility and compactness mean Giraffe 1X can be easily shifted, for example from a vehicle to the roof of a building, making it ideally suited to the rapidly changing needs of mobile forces.

Saab also presented its wide range of ground combat products including the AT4 Roquette NG, Carl-Gustaf M4, and


Giraffe 1X

NLAW. The Carl Gustaf M4, AT4 and NLAW weapons systems enables a modern fighting force to become "light, lethal and wired to meet the operational challenges of the 21st century." At Eurosatory 2016 Saab presented its whole range of support weapons and the interest for the systems is bigger than ever. The Roquette NG family, which includes AT4CS ER (anti-armour extended range), AT4CS AST (anti-structure and breaching), and AT4CS HE (high-explosive anti-personnel), was on site together with the newly developed lightweight multi-purpose weapon system Carl Gustaf M4. Also, Saab´s anti-tank weapon NLAW was showcased to the attending audience as a response to the increased demand in Europe for lightweight disposable anti-tank weapons.

Controp's helicopter camera payloads

Controp Precision Technologies announced several orders for its DSP-HD high definition EO/IR camera payloads for helicopter upgrades. The systems were recently supplied to several major customers including installation on United Nations (UN) Mi-17 helicopter, the Mi-24 helicopter, the Bell 407, and on the Eurocopter EC-145. Furthermore, the Controp QUAD-HD high definition multi sensor payload was also supplied recently to an "undisclosed Asian customer" to be installed on helicopters. The DSP-HD dual sensor payload includes a thermal imaging camera with zoom lens and image enhancement features, a full high definition (HD) day zoom camera, full HD daylight spotter channel and optional Eyesafe laser range finder (LRF) or optional laser pointer. Alternatively, the system may be offered with the SWIR long range camera, in place of the full HD daylight spotter channel. The QUAD-HD lightweight multi sensor payload includes a thermal imaging camera with continuous zoom lens and image enhancement features, a high sensitivity colour high definition (HD) zoom camera, optional Eyesafe laser range finder (LRF), optional laser illuminator or optional laser pointer.

Controp DSP-HD camera payload on a Mi-24 gunship

Elbit Systems Iron Vision and Seagull

After introducing cutting edge technologies that have revolutionised helmet mounted systems (HMS), Elbit Systems announced its latest development in the field: Iron Vision, an advanced HMS for commanders and drivers of closed-hatched armoured fighting vehicles, including all types of main battle tanks and infantry fighting vehicles. Iron Vision's 360-degree, high-resolution imagery is projected in full colour and zero latency to the wearer's visor, offering a clear and vivid display of the surroundings in both day and night and in all types of weather. The 'highly sophisticated' helmet and support system collects information from different digital sources within and around the vehicle. Iron Vision displays and tracks the positions of various features of interest,ranging from a single person standing or crawling several meters near the vehicle to a moving vehicle located 150–300 metres away. By using the helmet, the wearer obtains complete freedom of movement and is able to shorten the sensor-to-shooter cycle, all while remaining fully protected under closed hatches.

IronVision

Elbit Systems has also recently completed a trial test torpedo launch from its Seagull multi-mission, autonomous Unmanned Surface Vessel (USV) system. The trial, performed out of Israel's Haifa port, demonstrated the capability of Seagull to install and launch light weight torpedoes, adding to the advanced capabilities of the USV, which is designed to carry out unmanned maritime missions, such as protection of critical sea areas and high-value assets against submarines and sea mine threats. Introduced earlier this year, Seagull is a 12-metre long multi-mission USV system equipped with one or two vessels that can be operated and controlled in concert from manned ships or from the shore. "Seagull provides multi-mission capabilities and can be employed for ASW, MCM, EW, maritime security and other related missions, leveraging modular mission system installation and offering a high level of autonomy."

Seagull

Rockwell Collins new perimeter surveillance radar

Rockwell Collins introduced its PSR-500 Perimeter Surveillance Radar (PSR) at Eurosatory, which is a high resolution, compact radar with the capability to track and record intrusions in all weather (see photograph below). "The PSR-500 couples high performance with low power consumption to bring users affordable and reliable technology," stated Claude Alber, vice president and managing director, Europe, Middle East and Africa for Rockwell Collins. "Demand for this type of radar technology is growing to address the need for surveillance of geographical borders, critical infrastructures, industrial, commercial or sporting areas."

PSR-500 identifies mobile targets in all weather conditions, including rain and fog, 24 hours a day. It adapts to the surveillance needs of many types of locations, due to its relatively short range and target behavior analysis algorithms. In addition, the radar sensor can be combined with a camera that is controlled by radar detections, allowing for multi-target, highly accurate video visualisation and real-time recording. Compared to similar surveillance radars, PSR-500 requires less energy and emits low radiation, posing no health risk to the user.

Safran's NG Multifunction Infrared Binoculars

At the opening of Eurosatory, Martin Sion, Chief Executive Officer of Safran Electronics &Defence, introduced the company's new-generation multifunction infrared binoculars, JIM Compact which

JIM Compact

on the global success of the well-known JIM family of multifunction infrared binoculars, with some 9,000 units already in service or on order. It joins the wide range of portable optronic (electro-optical) systems and equipment offered by Safran. JIM Compact meets the "critical needs of today's armies to perform even the most demanding missions": all-weather observation, engagement and precise target location. It features a very compact, robust design, light weight (2 kg with batteries), and an intuitive man-machine interface, designed for day or night front-line operations.

MBDA unveils MMP on four different platforms

At Eurosatory 2016, MBDA presented its medium-range land combat missile system MMP integrated on four different combat platforms, thereby demonstrating the 'exceptional' modularity of this missile. Ideally suited for dismounted combat, MMP can also provide the main armament on light vehicles or be incorporated as a complementary armament on the turrets of heavy combat vehicles, reusing the existing electro-optics. An embedded configuration consists of the current infantry firing post that can be directly adapted to the upper platform of light vehicles. Thus, close combat units, as well as special forces, can instantly give non-dedicated vehicles an anti-tank capability to operate in theatres requiring mobility and stealth.

MBDA has also launched design studies for a 250 kg motorised turret for light armoured vehicles. A first prototype of this turret, called IMPACT,was presented on MBDA's stand mounted on the Dagger, a small armoured vehicle produced by Renault Trucks Defence. IMPACT carries the day/night sensors of the MMP fire control, as well as two ready-to-fire missiles and a 7.62 mm self-protection machine gun and its ammunition. The firing post commands are displayed remotely in the vehicle cab so that the crew remains safe from enemy fire and adverse weather conditions thereby increasing permanency in combat.

In addition, the MPCV turret, currently in series production for several foreign clients in its air defence version armed with four Mistral missiles, is also available in a land combat version reusing the same firing optronics. This version, adapted to medium tonnage vehicles, offers considerable firepower with its four MMPs installed in

Safran's Patroller on display at the event

individual launchers plus four missiles in the hold.

The MMP is also presented integrated in the T40 turret that will equip Jaguar, the French army's future Armoured Reconnaissance and Combat Vehicle. On show at the Nexter stand, this two-missile turret configuration demonstrates that the MMP can be easily operated through the fire control on the carrier. These extremely mobile armoured vehicles can therefore be equipped to destroy all types of targets, even the most hardened, at a range of over 4,000 meters, with all the precision and collateral damage prevention qualities that characterise MMP.

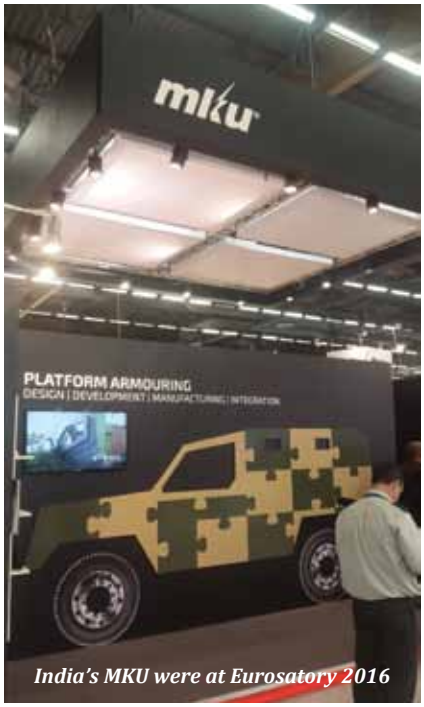
MMP is a latest-generation land combat missile fully adapted to modern conflict. It will replace the Milan and Javelin anti-tank missiles of the French Army and special forces from 2017 onwards as well as HOT in use French cavalry units. It is a "fire-and-forget" missile with a 4,000-metre range, a dual mode seeker (uncooled infrared and visible colour channels) and also a fibre-optic data link making it possible to maintain "man-in-the-loop" control.

Lockheed Martin guided MLRS rocket contract

Lockheed Martin has received a $332 million contract from the US Army for Lot 11 production of Guided Multiple Launch Rocket System (GMLRS) rockets. The contract calls for the production of GMLRS Alternative Warhead rockets, GMLRS Unitary rockets and Reduced-Range Practice Rockets (RRPRs) for the US Army, US Marine Corps and for Foreign Military Sales (FMS) to Israel, Finland, Jordan and Singapore. All production deliveries are anticipated to be completed by March 2018.

GMLRS is an all-weather rocket designed for fast deployment that delivers precision strike beyond the reach of most

The MBDA stand at Eurosatory

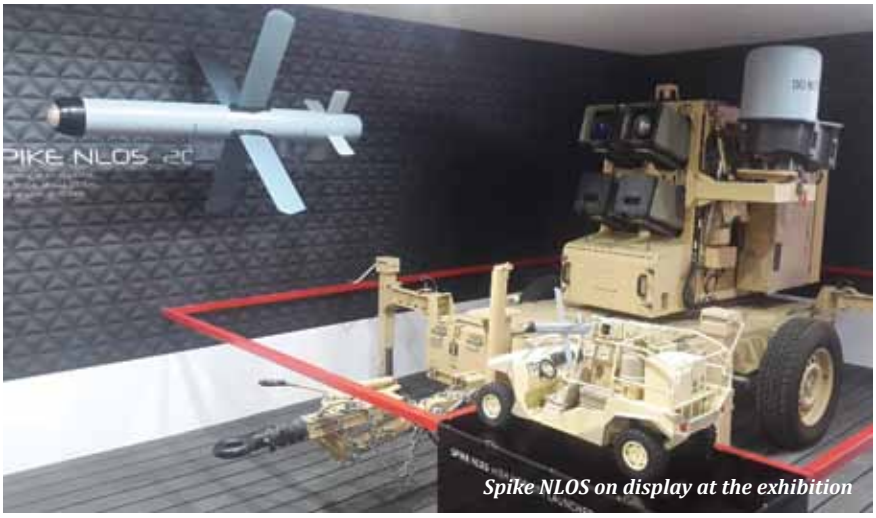


India's MKU were at Eurosatory 2016

conventional weapons. The new GMLRS Alternative Warhead (AW) was the first munition developed to service area targets without the effects of unexploded ordinance, complying with DoD cluster munitions policy. GMLRS Unitary rockets greatly exceed the required combat reliability rate and have established a reputation for affordability. The RRPR allows users to train with realistic, full-motored rockets with limited flight range, making them ideal for smaller testing ranges. In combat operations, each GMLRS rocket is packaged in an MLRS launch pod and is fired from the Lockheed Martin HIMARS or M270 family of launchers. Lockheed Martin has produced more than 30,000 GMLRS rockets at its facility in Camden.

Rafael at Eurosatory

Rafael Advanced Defence Systems revealed further improvements to the latest addition of its Spike SR (short range) tactical missile family. The capability of the original Spike SR, fitted with a tandem high-explosive anti-tank warhead to defeat main battle tanks equipped with explosive reactive armour, is being increased by the integration of a new penetration blast fragmentation warhead with a delay function, which has recently been tested successfully. This has been designed for use in urban operations, with the high-explosive fragmentation warhead penetrating the bunker or structure before detonating with lethal blast effect.



Spike NLOS on display at the exhibition

Rafale's Iron Dome on outdoor display

The Lockheed Martin stand at Eurosatory 2016

The standard Spike SR has a maximum range of 1,000m, but this is being increased to 1,500m to provide the operator with a greater standoff capability. The Spike SR is a lightweight man-portable system, weighing only 9.8kg. The missile is fitted with an advanced uncooled imaging infrared seeker and an advanced tracker and operates in the fire-and-forget mode .Once fired, the launcher and its associated day sighting system are discarded.

IAI introduces Personal SATCOM and Drone Guard

At Eurosatory 2016, IAI presented a wide range of advanced, proven warfare systems for land forces. This included Tactical Weapon Systems (a range of tactical precision - guided weapons with laser and GPS guidance, for small vehicles or tank-launched missiles through loitering weapons and up to long range missiles), Unmanned Systems (Unique tactical fixed wing UAV systems, including those with hovering and vertical takeoff and landing capabilities. IAI also offers a range of unmanned ground vehicles and battlefield engineering solutions), ISR (IAI's ground based intelligence, surveillance and reconnaissance solutions deliver real time information for military and other uses) and C4I (Advanced Command and Control with integrated networks and situation - awareness systems provide real time ISR and control of the battlefield).

A Compact Phased Array SATCOM for land forces was revealed at the exhibition. The ELK-1882A 'On-the-Move' (OTM) Personal SATCOM micro-terminal provides personal bi-directional voice and data communication for lower echelon ground combatants. The ELK-1882A micro-terminal comprises a phased array antenna, a Software Design Radio (SDR) module, and an energy module or battery-pack. Operating in the Ku frequency band via commercial geostationary communications satellites, it complies with ITU spectrum density regulations and commercial communication satellite operator standards.

Israel Aerospace Industries (IAI) is viewing a steadily increasing demand for its Drone Guard detection and disruption counter UAV system, for both military and civilian applications. The recently unveiled system has already been purchased by several customers for critical asset and personnel protection. Numerous potential customers have reportedly attended dedicated demonstrations of the system versus various drone threats, with more demonstrations anticipated for the coming months. The use of small drones has increased dramatically over the years, making them a potential threat to critical infrastructures, other aircraft and homeland security (HLS), due to their small size, low speed and low flight altitude.

IAI is offering specially designed 3-Dimensional (3D) radars and existing Electro-Optical (EO) sensors for detection and identification, as well as dedicated Electronic Attack (EA) jamming systems for disrupting drone flight.

IAI's stand at the event

VSC


IAI's Drone Guard detection and disruption counter UAV system

Visit to Airbus DS in Germany

TMB'16

The Airbus A400M

Another year, another great and informative Trade Media Briefing (TMB'16). The location this time: Germany! Organised by the very efficient TMB Team, the event was spread over 17-22 June (and that included arrival and departure dates for the invited media).

TMB'16 began with an informal dinner at the Hilton Munich Park Hotel, Munich on 19 June which was rapidly succeeded in the next few days with travelling to various company locations for briefing and factory visits. Over 80 media persons from around the world were in attendance this time around.

On 20 June, the team left for Ottobrun to the company's offices starting with opening remarks from Dirk Hoke, CEO Airbus Defence and Space and then the 'Market Outlook' from Jean Pierre Talamoni, Sales & Marketing. Following the interesting session on 'Technology' by Miguel Ángel Morell, HO Engineering, we were briefed in detail on Unmanned Aerial Systems by Jana Rosenmann, HO Unmanned Aerial Systems. After lunch, there was a talk on the 'Light & Medium Aircraft Family' by Fernando Ciria, HO Marketing, Tactical Airlifters & ISR followed by 'Supporting Military Aircraft in Service' by Stephan Miegel, HO Military Aircraft Services.Talks that followed were on 'Eurofighter' by Alberto Gutierrez, HO Eurofighter Programme and the 'A400M' by Fernando Alonso, HO Military Aircraft.

After the heavy to the lighter programme: in the evening, we were ferried for dinner to

First Airbus A400M for Spain

The first Airbus A400M destined for the Spanish Air Force has finished its painting process and appeared in the colours of the customer. The aircraft, production number MSN44, left the paintshop at the final assembly line (FAL) in Seville and will now undergo ground tests in preparation for its first flight.

The C295W with an A400M in the background (photo: Airbus)

an extremely charming hotel and restaurant Lieberhof Tegernsee on the breathtaking surroundings of Lake Tegernsee.

The next day, we visited Airbus Helicopters' production lines at Donauworth. Before the briefings on helicopters themselves, Jeronimo Amador, HO Marketing MRTT & Other Airbus Derivatives, updated us on 'Tanker and Military Derivatives'.

The Airbus Helicopters programme began with an H145M Royal Thai Navy doing a flight demonstration and an H145M on static display briefing by Mark Henning, H145 Programme Governmental business. A very interesting presentation on the 'HForce weapon system' was given by Phillippe Kohn, Sales Promotion Manager followed by 'New generation light-twin training helicopters – UKMFTS' by Ian Morris, VP Head of Defence Business Airbus Helicopters UK.

The tour ended with the Donauworth site tour where we were taken to the composite shop, civil and military FAL (Final Assembly Lines), NH90 SeaLion as well as Military MRO activities.

As always, an extremely informative and well planned event.

Airbus DS orders A330 MRTT Simulator

Airbus Defence and Space has placed an order for the development and provision of a Full Flight Simulator (FFS) to support the training of crews on the A330 Multi Role Tanker Transport.The contract, signed with Indra of Spain, covers the installation at the Airbus Defence and Space International Training Centre in Seville of a Level D FFS, which is certified to qualify pilots on the A330 MRTT with zero flight time on actual aircraft. In addition to providing pilot flight-training, the new FFS, which will enter service in the second quarter of 2018, will permit the training of pilots in hose-and-drogue refuelling operations, and to act as a receiver from other tankers.

The A330 MRTT, A400M, C295

In this issue we will cover the MRTT, A400M and the C295. Our following issue (*V/2016*), shall focus on Airbus Helicopters.

Airbus Defence & Space is planning to develop an automatic air-to-air refueling (AAR) and refueling kit for the C295 airlifter. The company is also working on helicopter refueling from the A400M airlifter, which has been creating problems at the moment because of hose length issues: "they are working on it". The company has developed image-processing software that automatically steers the refueling boom toward the receiver aircraft's receptacle which could reduce risk and save time in operations; however, the boom operator would still have to manage the initial extension of the boom and its disconnection and retraction.

A prototype hose-and-drum mounted on a pallet has been fitted to the C295 and the hose feeds through a tunnel that is fitted to the airlifter's ramp. An Airbus Helicopters H225 Caracal heavy helicopter has flown behind the C295 to check for airflow issues. Up to seven metric tons of fuel can be dispensed from the C295's internal fuel tanks and also from an auxiliary fuel tank fitted in the fuselage.

As for the A400M, it is now cleared to refuel fighters and transports from underwing pods. Fernando Alonso, HO Military Aircraft, said that Airbus remained committed to the troubled A400M tactical transport, despite financial pressures that the project was causing. He described the A400M's development and production issues as "never-ending", with its latest problem being the Europrop International TP400 engine's propeller gearbox. Operators were required to conduct inspections after every 20 flight hours and replace the affected part every 100h, a situation which he says was "absolutely unacceptable, and operationally a nightmare." An interim fix for a gearbox component cracking issue had been certificated by the European Aviation Safety Agency and this would allow component life to be increased to 650h, and then hopefully to 1,000h and more. "The team had full faith in the A400M programme and that there was no way back".

The A330 MRTT is the "only new-generation Multi Role Tanker Transport aircraft fully certified, in operational service and combat proven now". It uniquely offers military strategic air transport as well as 'superior' air-to-air refuelling capabilities that have already been extensively proven in numerous real operations by current operators. With 46 aircraft sold to 6 major air forces (Australia, Saudi Arabia, United Arab Emirates, United Kingdom, Singapore and France), the A330 MRTT is the "preferred tanker/transport solution for current and future needs".

Able to carry up to 111 tonnes / 245,000 lb of fuel in its wings, the basic fuel capacity of the A330-200 airliner, from which it is derived, enables the A330 MRTT to 'excel' in air-to-air refuelling missions and refuel any kind of receiver, without the need for any additional fuel tank, hereby avoiding any reduction in its ability to carry passengers or cargo.Thanks to its intrinsic wide-body fuselage, the A330 MRTT offers a variety of configurations. It can be used as a pure transport aircraft able to carry up to 300 troops, or a payload of up to 45 tonnes/99,000 lb. It can also easily be converted to accommodate up to 130 stretchers for Medical Evacuation (MEDEVAC) missions.

The A330 MRTT is certified for two-crew transport operation and fully benefits from the latest advances in commercial aircraft cockpit design, including advanced avionics, the only state-of-the-art human machine interface (HMI) in service and Fly-By-Wire (FBW) controls. It provides higher reliability, by reducing crew workload and enhancing situational awareness, thus dispensing crews with spare capacity to enhance mission success.The A330 MRTT is offered with a customised suite of military avionics and a mission system integrated with civil avionics and is fitted with a comprehensive state-of-the-art self-protection system to ensure their survivability in a high-threat environment, including a Defensive Aid System (DAS), fuel tank inerting system and an armoured cockpit.

On to the A400M which is the proven and certified "Most Advanced Airlifter with 21st Century State-of-the-Art Technologies". It can airlift in its large cargo hold most critical armed forces equipment which did not fit in previous generation tactical airlifters including helicopter or a heavy infantry fighting vehicle or a heavy humanitarian excavator.

Airbus DS designates TAF as regional support centre for CN235

Airbus Defence and Space has designated the Turkish Air Force's 2nd Air Supply and Maintenance Centre (2nd ASMC) in Kayseri as a regional support and maintenance centre for Airbus CN235 aircraft following a detailed certification process conducted over the last year. Turkey is the world's largest operator of CN235s with 59 aircraft and has accumulated much expertise in the maintenance, repair, overhaul and updating of the aircraft in 20 years of operations.

Airbus DS and Roketsan to integrate weapon systems on C295W

Airbus Defence and Space and Roketsan Missiles Industries of Turkey have signed a Memorandum of Understanding to integrate a range of weapon systems on the C295W surveillance and transport aircraft. Under terms of the agreement, the companies will collaborate on the design aspects, integration and initial testing phases of a variety of weapons from Roketsan's existing product range. Systems to be integrated onto the market-leading C295W include at least: the 70mm laser-guided missile 'Cirit'; laser-guided long-range anti-tank missile 'Lumtas'; and laser-guided bomb 'Teber'.

C295 refuelling an Airbus Helicopter H225

The A400M programme was launched in May 2003 to meet the combined needs of seven European Nations regrouped within OCCAR (Belgium, France, Germany, Luxemburg, Spain, Turkey and the UK), with Malaysia joining in 2005. The A400M made its first flight on 11 December 2009 and the first production aircraft was delivered to the French Air Force in August 2013. The A400M has already seen operational use with the French and Turkish Air Forces in Afghanistan, the Central African Republic, African' Sahel Region, Mali and in the Middle East to support the air operations over Iraq and Syria.

Designed from the outset to be a dual-role transport and tanker aircraft, the A400M provides air forces with a cost- effective way for air-to-air (AAR) refuelling in addition to being a versatile logistic and tactical airlifter. The standard A400M aircraft has much of the equipment and software provisions for 2-point air-to-air refuelling operations already installed. Any A400M can be rapidly reconfigured to become a tactical 2-point tanker able to refuel probe-equipped receivers at their preferred speeds and altitudes. It has a basic fuel capacity of 63,500 litres (50,800 kg) which can be even further increased with additional cargo hold tanks.

The A400M can accommodate up to 116 fully equipped paratroopers, carrying them to the drop zone at speeds up to 300kt, but dropping them at as slow as 110kt to ensure minimum dispersion. Crucially, two streams of paratroopers can

A400M qualifies paratrooping capabilities

Airbus Defence and Space is conducting intensive paratrooping trials with the A400M new generation airlifter. The picture shows 30 paratroopers being dropped at the Tarbes drop zone in southern France and certification of this capability is "imminent." Continuing trials will move stepwise to 40 paratroopers and beyond as the capability is demonstrated in flight tests.

simultaneously jump from the ramp or the two side doors to further cut jumping time and scatter. Careful aerodynamic design reduces turbulence behind the aircraft and deployable baffles at the door exits protect jumpers from the airflow. The aircraft is also fitted with a winch, allowing any ´hung-up´ static-line paratrooper to be safely retrieved. The type's low speed characteristics make the A400M ideal for dropping supplies from low altitude. The A400M can airdrop up to 25 tonnes / 55,100 lb of containers or pallets through gravity and parachute extraction. The Computed Air Release Point (CARP) linked to the Automated Release System, automatically computes the release point for optimum delivery accuracy, including corrections for wind effects.

The medium tactical transport, C295 is a "new generation, very robust and reliable, highly versatile airlifter" able to carry up to nine tonnes of payload or up to 71 personnel, at a maximum cruise speed of 260 kt /480 km/h. Fitted with a retractable landing gear and pressurised cabin, it can cruise at altitudes up to 25,000 ft, while retaining short take-off and landing (STOL) performance from unprepared short, and unprepared airstrips, as well as low level flight characteristics. Powered by two Pratt & Whitney Canada PW127G turboprop engines, the C295 provides "excellent"manoeuvrability, "outstanding" hot and high performance, low fuel consumption with, consequently very long endurance of up to eleven hours in the air. First delivered in 2001, the C295 is a developed version of the well-known CN235, offering greater capacity and range.

Airbus DS to operate Heron 1 drones for Germany in Mali

The German Defence Procurement Agency (BAAInBw) and Airbus Defence and Space have signed a contract to provide Heron 1 surveillance drones to support the Bundeswehr mission in Mali. Similar to the mission in Afghanistan active since 2010, the unmanned aerial systems will be leased from Israeli manufacturer IAI and operated by Airbus. Military missions will be also in future be flown solely by military personnel. The operations in Mali will start in November 2016 and are initially planned until February 2018. The extension of the Heron 1 operational model is paving the way also for the next drone generation Heron TP, which has been selected by the German Bundeswehr to succeed the Heron 1 and bridge the timeframe until a European drone development becomes available.

German Heron1 in Afghanistan

With the new C295W version equipped with winglets, the aircraft is capable of transporting more payload over larger distances in hot and high conditions resulting in fuel savings of around 4% and increased safety margins in mountainous regions.

An Airbus A330 Multi Role Tanker Transport (A330 MRTT) of the Royal Australian Air Force has successfully refuelleda F-35A Joint Strike Fighter of the US Air Force. (photo: USAF)

Being 12.7 m / 41 ft 8 in long, the C295 has the longest unobstructed cabin in its class. It can accommodate up to 71 seats, offering a much higher personnel carrying capability "than its competitors in this segment." For the same reason, it can carry palletised cargo(up of five 88 inch X 108 inch standard HCU-6E pallets) with direct off-loading through its rear ramp door.

The C295 aircraft is combat proven and has successfully completed military missions in all types of environment. It routinely operates in the hot and humid environments of the Brazilian jungle and Colombian mountains, in the dusty and very hot deserts of Algeria and Jordan, and in the extremely cold winters and icy conditions of Poland and Finland. The C295 has been successfully employed during long deployments (up to two years, flying up to 90 hours per aircraft per month) in remote areas, such as Chad, Iraq and Afghanistan.

VSC

(Coverage on Airbus Helicopters will be in Vayu's Issue V/2016)

Russian Might on Parade

A mixed formation of Su-27s and MiG-29s from the Russian Knights and Swifts display teams respectively dispensing flares over Moscow

This year's Victory Day Parade took place in Red Square, Moscow on 9 May, commemorating the 71st anniversary of the defeat of Nazi Germany in 1945. General of the Army Sergey Shoigu, Minister of Defence of the Russian Federation, inspected the parade with Russian President Vladimir Putin also in attendance as hundreds of military personnel and a range of military weapon systems were paraded.

Russian military vehicles on the ground were led by a WWII-vintage Soviet T-34/85 tank, followed by more modern ground vehicles such as the T-90 MBT, BMD-4 IFV, 9K720 Iskander tactical ballistic missile, S-400 SAM system, RS-24 Yars road-mobile ICBM, 2S35 Koalitsaya-SV self-propelled 152mm howitzer, Ural Typhoon mine-resistant vehicle, and the new T-14 Armata MBT, T-15 Armata IFV, and Kurganets-25 APC/IFV.

Overhead, helicopters, heavy airlifters and fighters flew past in formation, the types including the Mi-17, Mi-25, Mi-26, Mi-28 and Ka-52 helicopters, MiG-29 and Su-27 family fighters, Su-25, Su-24 and Su-34 strike aircraft, Tu-22M3, Tu-95 and Tu-160 bombers (the latter marking the first appearance of the modernised Tu-160BM1 variant), plus An-124, Il-76 and An-22 heavy transport aircraft. The Yak-130 aerobatic team 'Crimean Wings' as well as the Su-27 display team 'Russian Knights' and MiG-29 team 'Swifts' also performed flypasts.

Russian President Vladimir Putin at the parade on 9 May (photo: kremlin.ru)

Mi-17 helicopters flank a Mi-26 over Red Square

A contingent of active servicewomen, from the Military University of the Ministry of Defence and the Military Academy of Material and Technical Security, was on parade for the first time

WWII-era Soviet T-34/85 tank on parade

RS-24 Yars ICBM on parade

T-14 Armata MBT at Red Square

Column of T-90A battle tanks on parade

(all photos: kremlin.ru)

KADEX 2016

The Kazakhstan Defence Expo, or KADEX 2016, is one of the very few possibilities to see the Kazakh Air Force in action. This year was the exhibition's fourth edition, and after a relatively tame showing in 2014, this year was different. No less than six upgraded Su-27s and three brand new Su-30s were present, most of which flew demonstration every day. An upgraded Su-25 was also displayed on the ground. But for many enthusiasts the highlight of the show arrived after the official closing ceremony, when an An-12 landed as support for the fighters.

The daily air power display, combined with a ground demonstration of Special Forces, were impressive affairs. There was great emphasis on helicopters, with three locally assembled Airbus EC145 displaying each day. "The use of helicopters as one of the modern means of warfare can further increase the power of armed forces, and are indispensable during operations conducted by special forces, for fighting illegal armed groups, terrorists, drug trafficking and for border patrol," said Russian Helicopters' CEO Alexander Mikheev. This was complemented with daily demonstrations by the new multi role Ansat-K utility helicopter, upgraded Mi-35M and Mi-17V-5. The Russian delegation also had a large Irkut participation, with special prominence given to the Yak-130 trainer.

Many other helicopters were on static display, from a massive Mi-26 to the small and agile EC155, many different versions of the well-known Mi-8/17 family, including brand new Mi-171s as also heavily upgraded Ukrainian Mi-8s. The latter carried out a range of impressive daily demonstrations. A few transport aircraft were on static display, including a new An-74 of the Kazakh Border Guard and the last of four recently delivered Airbus C295Ms.

Su-27s dispense flares during their display

The venerable An-12, in logistic suppport of the Su-30s

Russian Helicopters' Kazan Ansat-K

Air crew of one of the new Su-30s after their impressive display

The last of four Airbus C295Ms ordered by Kazakhstan, recently delivered

Text and Photos: Patrick Dirksen

Irkut at KADEX 2016

UAC subsidiary Irkut Corporation had comprehensive displays at KADEX-2016, the fourth international exhibition for weapons systems and military equipment held at Astana in Kazakhstan from 2-5 June 2016. The company's stand featured a model of the Yak-152 basic trainer which, along with the Yak-130 lead in fighter trainer (LIFT), flight simulators, and computerised classrooms, forms a full-featured training complex. In addition, a single Yak-130 combat trainer in a distinctive red-and-white Yakovlev Design Bureau colour scheme carried out daily flying displays. Irkut-built Kazakhstan Air Force Sukhoi Su-30SM multi-role fighters also flew aerobatic displays each day.

Yak-130s are now in service with multiple Air Forces, and by May 2016, the Russian Air Force had received 70 Yak-130s : the Russian Air Force will eventually operate over 100 of the type. Export customers for the Yak-130 include Algeria, Bangladesh and Belarus, and active discussions are underway with a number of other countries.

Su-30SM multi-role fighters, derived from the Su-30MK family of fighters such as the Indian Su-30MKI and Malaysian Su-30MKM, have been delivered to the Russian Air Force beginning in 2012 and the Russian Navy since 2014. In April 2015, the first batch of Su-30SMs was delivered to Kazakhstan (*see Vayu III/2015*). The type has since been operationally deployed to Syria (*see Vayu III/2016*), leading to greater interest in the aircraft in Russia and internationally.

The Su-30MK family has been in production since 2002, and variants are in operation with the Air Forces of India, Malaysia and Algeria. Some 300 have been delivered in total, against a cumulative order book of around 330.

'The Next Generation: Inspiring Innovation'

Stealth bonanza at RIAT 2016

The Lockheed Martin F-35B STOVL fighter made its European air show debut at the Royal International Air Tattoo held on 8-10 July, while the F-35A made its UK debut at the event. USAF F-22s were also welcome returning participants this year, turning RAF Fairford into a veritable cornucopia of stealth fighters! Vayu's Angad Singh was on hand to report.

This year's Royal International Air Tattoo had the theme 'The Next Generation: Inspiring Innovation,' and the presence of three stealth fighter variants at the show certainly helped make that a reality! The USAF sent two Lockheed Martin F-22 Raptors and three F-35A Lightning IIs, while the STOVL F-35B model was represented by two US Marine Corps aircraft and one RAF example. The fifth-generation fighters were easily the star attractions of the show, generating significant media and enthusiast attention in the days leading up to RIAT 2016. Showgoers thronged to these aircraft in the static park, and when they were in the air, there was not an eye that was not turned skyward.

RAF Red Arrows in formation with Eurofighter Typhoons and an F-35B

Lockheed Martin F-22 and F-35, stars of RIAT 2016

The F-22s and F-35As were meant to carry out a three-ship heritage flight each day, in formation with a P-51D Mustang, but a series of issues prevented this from ever happened! On the first two days of the show, the Mustang was grounded owing to inclement weather at its home airfield,

Cold War era jets were in attendance alongside futuristic stealth fighters, with the Polish MiG-29 being especially popular with the audience

leaving the two fifth-generation types to conduct the flypast without its 'heritage' element – not that anyone was complaining overmuch, given that two stealth fighters flying low and slow in formation is a visual treat regardless. On the final day of the show, the Mustang arrived over Fairford only to discover the F-22 grounded with a technical snag, again reducing the planned display to a two-ship.

In the event, the star 'set piece' of the show was probably the all-RAF flypast of the Red Arrows display team leading a pair of Eurofighter Typhoons and the F-35B.

On the other hand, the stealth fighter solo displays were among the most impressive of the show. The Raptor, returning to the show after six years, put its vaunted abilities to good use, carrying out an enthralling (and very loud!) display every day. The F-35B display was a much tamer affair, until the aircraft pulled off its signature 'party trick' – and what a trick it is! The transition from level flight to a stationary hover looked and felt like something out of science fiction, even more so than with aircraft like the Harrier. In Britain, the country that created the first-ever 'jump jets,' there is a deep emotional link to any aircraft that 'does the impossible.' The crowds at Fairford were electrified seeing the next generation of UK air power demonstrate a capability that many thought was gone forever when the 2010 Strategic Defence and Security Review abruptly retired the British Harrier force.

[Detailed show report to follow in next issue]

Photos: Angad Singh

The French Air Force 'Ramex Delta' team performed their last-ever RIAT display in 2016, as the team is to be disbanded later this year

The Royal Navy's 'Black Cats' team with AgustaWestland AW159 Wildcat HMA.2 helicopters flew impressive daily displays

Indian Monsoon at Farnborough Airshow 2016

Worth a thousand words : typical weather every day of the Show

While the British grumble about the 'typical English weather', we Indians actually love it! After all, when we visit the UK for work or pleasure, the intermittent rain and generally cool weather is always a travel bonus; a great escape from the sweltering heat and humidity back home. So, we never understand why everyone complains about it so much; a common reply we give is "wait till you come to India and experience the heat, then you'll appreciate it"! Yes, we love the English weather but as they say "the grass is greener on the other side" !

However, what we Indians (and people from other countries) certainly did not expect was 'an Indian monsoon' at the Farnborough Show. On day one, it rained so hard that the organisers had to abandon the proceedings halfway through the day and asked all visitors/ exhibitors to shut shop and evacuate the premises! There were reports of halls getting flooded, water leaking through roofs, potential electrical short-circuiting and knee deep water logging. The urgency with which the organisers asked the crowd to leave reminded one of an imminent enemy attack in a war zone! To be cautious, yes. But the overreaction and panic by the organisers left people amused. And angry. Why angry? Because when you ask thousands of people to leave a venue all at once, there are bound to be the obvious problems: not enough buses and taxis to 'evacuate' people to the train stations, horribly long queues to get into the buses itself and then extra-long lines to get into the Farnborough train station. Oh, I forgot: completely drenched too. All literature and plastic bags collected from companies were used as umbrellas! Multi-purpose indeed!

The announcement of Virgin Atlantic Airways' agreement to acquire 12 A350-1000s included top management presence from Rolls-Royce, Airbus and Virgin Atlantic Airways

John Leahy, Airbus' Chief Operating Officer, Customers at one of several media briefings (photo: Airbus)

So, on day one, it took an average of 2-3 hours to get to get into the Show, another few hours at the Show (while it poured and stopped any kind of work anyway) and then about 3 hours 'evacuating' in the pelting rain back. Not a good sign of things to come for the rest of the show ! But, barring day one, rest of the show went off fairly smoothly with minor glitches like perpetual, but tolerable, light rain and the occasional cancellation of flight displays.

Thanks to such chaos, one was expecting exciting and vicious headlines in the various show dailies the next day. It was not: just a whimper. Had this happened in India at Aero India or Defexpo, the knives would be out. Organisers DEO/MoD would have never heard the end of it from exhibitors, visitors and media alike. But then these things can happen anywhere and there is nothing one can do about it!

But Farnborough Airshow is the Farnborough Airshow and we all love it! And needless to say, shall be back!

Count your blessings

So, at close of the five day Farnborough International Airshow (FIA) trade exhibition, organisers confirmed that there were recorded orders and options to the value of US$123.9 billion, defying industry expectations. A total of 856 aircraft valued at US$93.98, 1,407 engines valued at US$22.7 billion and a variety of other business deals totalling £7.2 billion were signed. As the trade day drew to a close, FIA welcomed over 6,000 young people to the show for its STEM outreach programme *Futures Day*. Star of the show was Tim Peake who opened proceeding in his first public appearance since returning from the ISS just four weeks before the event.

The 2016 show was opened by both the then Prime Minister, David Cameron, MP and current Virgin Atlantic President, Sir Richard Branson who welcomed senior aerospace executives, military officials and international government representatives on 11 July, marked by a fly past by the F-35 Joint Strike Fighter flanked by the Red Arrows. Headline grabbing deals over the week included Virgin Atlantic concluding its purchase for 12 Airbus A350-1000 and the UK Government confirming the purchase of 50 Apache Helicopters and 9 Boeing P-8 Poseidon aircraft. Topping the order chart was AirAsia who signed up for 100 Airbus A321neos.

Speaking at the end of the event, Farnborough International Chief Executive, Shaun Ormrod said, "The extreme weather bought us some additional challenges, but it doesn't seem to have stopped our exhibitors and visitors doing business. The halls have been busy all week, which is really encouraging for the supply chain industry. With these orders adding to the already large backlog, its looks like the aerospace industry is going to be busy for some years to come." Commercial Director Amanda Stainer further added, "It's been

MBDA announces Brimstone 2 in Apache testing

MBDA announced that they and Boeing had completed first firing of the former's Brimstone 2 air-to-surface missile from an AH-64E attack helicopter in June 2016. The system, which its developer calls the Future Attack Helicopter Weapon, is being marketed as the primary armament for the British Army's future fleet of AH-64Es.

Conducted at the Yuma Proving Grounds in Arizona, the firing was performed nine months after the MoD in September 2015 funded MBDA to demonstrate the weapon. The work has been split into three phases. The first looked at the feasibility of integration, while a second element – also now completed – covered the rapid functional integration of the Brimstone 2 and its subsequent firing. A remaining third phase will see full integration, and this is now under discussion with the MoD ahead of a contract award.

The Airbus A400M carried out daily flight demonstrations

Taking part in daily flight demonstrations was the Airbus A380 (Vayu's cover story)

a really successful show for our exhibitors. Our marketing suite has been busy and we have already taken a considerable number of re-bookings for the 2018 show. The *Meet-the-Buyer* programme has gone well with over 1,700 meetings taking place as have the military delegations and civil and commercial delegations programme which as needs representation from over 60 countries."

During the Farnborough Airshow, Airbus won $35 billion worth of business for a total of 279 aircraft, covering both single-aisle and widebody aircraft families. The deals comprised firm orders for 197 aircraft worth $26.3 billion and commitments for 82 aircraft worth $8.7 billion.Sales and commitments at FIA of the A320 Family were strong, with business accounting for a total of 269 aircraft worth $31.3 billion. This total comprises 187 firm orders worth $22.6 billion, and commitments (eg. MoUs) for 82 aircraft worth 8.7 billion. Notably the larger A321neo model took a lion's share of the single-aisle announcements – with firm selections from three airlines for 140 aircraft, reflecting the trend for airlines to upsize to larger single-aisle aircraft.

In the widebody segment Airbus won firm orders for 10 aircraft worth $3.4 billion comprising two A330-300s and eight A350-1000s. In addition to these new widebody orders, the show also saw the launch order from DHL Express for the A330-300 Passenger-To-Freighter conversion programme, in partnership with EFW and ST Aerospace.

Virgin Atlantic and Airbus announced an agreement, for 12 Airbus A350-1000 aircraft. The aircraft, powered by Rolls-Royce Trent XWB engines, continues Virgin Atlantic's investment in "a greener, cleaner, quieter fleet." The A350-1000, which will replace Virgin Atlantic's remaining Boeing 747-400s and Airbus A340- 600s, is due for delivery from early 2019. As Virgin Atlantic President Sir Richard Bransonsaid, "We're thrilled to welcome the A350 to Virgin Atlantic. It is an outstanding aircraft from both a customer and sustainability point of view. Sustainable growth and meeting our carbon targets is incredibly important to us, and the aircraft's environmental credentials were a genuine factor in our selection. We will be pairing its cutting edge customer proposition with our own Virgin magic to give customers the best possible experience."

Boeing 787 Dreamliner of ANA

SportJet by Sukhoi unveiled

Sukhoi Civil Aircraft introduced the concept of a new aircraft designed to fly professional sports teams, SportJet by Sukhoi and the airliner is scheduled for release and certification in 2018.

SportJet by Sukhoi will be the third product in the range of Sukhoi Civil Aircraft alongside the Sukhoi Superjet 100 and Sukhoi Business Jet concepts, expanding the product markets and promotion opportunities. According to the experts at Sukhoi Civil Aircraft, sports air transportation market now exceeds USD 600 million per year.The concept is based on the expertise and technology of Sukhoi Superjet 100, enhanced by innovative medical and IT solutions developed in cooperation with sports physicians, experts and managers. It creates a home field advantage in the air, allowing athletes to rest and recover.SportJet by Sukhoi is based on scientific and practical research in the field of sports, such as the impact of flights, jet lag, hypoxia, dehydration, stress on the body and aerophobia that affect professional athletes from various sports.The layout of SportJet by Sukhoi will feature four functional zones: the flight zone of the first team, the recovery zone, the coaching zone and administrative area.

What also made news at FIA 2016

Elbit launches Light Spear and Spectro XR

Light Spear

Elbit Systems have launched the Light Spear, a new and unique self-protection and jamming system for UAS. An Electronic Support Measures (ESM) and Electronic Counter Measures (ECM) system for UAS, Light Spear is a compact EW system based on multiple DRFM (Digital Radio Frequency Memory (jamming channels, working in parallel and covering a wide spectrum. The system enables easy integration with an array of transmitters and platforms, and its low Size, Weight and Power (SWaP) consumption makes it well suited for UAS platforms operating in hostile environments.

The company also launched the Spectro XR,the latest and most advanced electro-optic payload developed by them for Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) missions. This is an ultra-long-range, day/night, multi-spectral electro-optical ISTAR system that provides 20" payload performance in a 15" payload. The heart of the system is a large multi-spectral imaging system that combines multiple cameras into one, allowing it to significantly improve performance without increasing size and weight. It implements up to 9 advanced and fully digital sensors (Medium Wavelength Infrared - MWIR, Visible and Near Infrared - VNIR and Shortwave Infrared – SWIR) and lasers with a very high level of stabilisation, providing users with high performance in adverse weather conditions.

Spectro XR at the Elbit booth

MBDA showcases Spear for the F-35

MBDA showcased its next generation air-launched networked precision strike weapon, Spear, for which the company has recently been awarded a £411M weapon development contract by the UK MOD. It is to be operated by the United Kingdom's F-35 Lightning II and will provide the aircraft with a unique strike capability, fully exploiting its advanced sensor and network capabilities. Spear is being developed to precisely engage long range, mobile, fleeting and re-locatable targets in all weathers, day or night, in the presence of countermeasures, obscurants and camouflage, whilst ensuring a safe stand-off range between aircrew and threat. Prior to being contracted for its development phase by the MOD, the Spearprogramme underwent an extensive set of test and trials activities, as part of an Assessment Phase contract. The results demonstrated that the missile's subsystems and functional chains meet the key criteria of the UK's Spear Capability 3 requirement. Successive tests focused on the guidance chain, including seeker and data link, lethal package, including warhead and fusing, culminating in the first air launch demonstration of controlled flight involving the missile's airframe, navigation and propulsion systems.

Thales and Inzpire in MoU

Thales is enhancing its simulated training offering by integrating its Air Mission Training System with the operational knowledge and experience of the UK SME Inzpire. Thales and Inzpire signed a Memorandum of Understanding (MOU) at the Farnborough International Airshow to deliver this new mission training.Inzpire's training expertise is an important addition to Thales's Air Mission Training System, as its operationally experienced team develops simulations which create the most realistic and immersive training environment possible.The Thales Air Mission Trainer system recreates the mission environment in high fidelity, enabling multiple crews to train together from multiple locations, bypassing the resource constraints of live flying. It can be tailored to a customer's operational requirements, assets, doctrine and partners, and is rapidly adaptable to different aircraft types, to optimise training effectiveness and costs.

MBDA'S Brimstone enters RAF service

The latest version of MBDA's Brimstone precision strike missile has formally entered service on the RAF's Tornado GR4, a significant step in the spiral development of the Brimstone weapon. It introduces an insensitive munition compliant rocket motor and warhead. Together with an enhanced version of MBDA's unique Dual Mode Semi-Active Laser/ Millimetric Wave seeker and an enhanced autopilot this significantly increases the weapon's envelope (off-axis and maximum range). Carriage of the Brimstone three-missile launchers and missiles was also part of the flying display at Farnborough Air Show for the first time. Brimstone will enter service on Typhoon as part of the P3E programme and the Royal Air Force's 'Project Centurion.'

Thales and Elettronica MoU for Electronic Warfare

Thales and Elettronica signed a Memorandum of Understanding (MoU) to strengthen their industrial and commercial operations and relations in the aerospace and defence business. The aim of the agreement is to explore joint initiatives and pursue growth business opportunities in the Electronic Warfare (EW) segment. "This MoU extends the area of our long-standing business relationship and both companies believe that it represents a fundamental step for growth in Europe and the International Market," said Enzo Benigni, Chairman and CEO of ElettronicaSpA. The two companies are already leaders in aerospace and defence technology and this new collaboration will offer even more synergisms to customers worldwide, building the largest EW pole in Europe.

Rafael and Northrop team offer Toplite for V-22

Rafael and Northrop Grumman are teaming to offer the former's Topliteoptronic system for the US Marines Corps' Bell Boeing MV-22 tiltrotor.The two companies teamed to respond to a request for proposals issued for an advanced optronic system that is needed to improve the operational capabilities of the MV-22 in different combat scenarios. Toplite is based on the technology of the Litening targeting pod used by the US Air Force and USMC, and the two companies previously teamed the Litening 5 for the US Navy's Boeing F/A-18. Toplite is also currently undergoing acceptance tests on the Italian army's Mangusta A-129 helicopters, and will serve as the main targeting system of this helicopter that will also carry the company's Spike anti-tank missiles. Toplite is a stabilised, multi-role, multi-sensor optronic payload designed for day/night observation and targeting. It is currently offered as a standalone system or as part of a weapons package that includes a member of the Rafael Spike missile family.

IAI and Honeywell in partnership

Honeywell is partnering with Israel Aerospace Industries (IAI) to jointly develop a 'sense-and-avoid' capability for IAI's Heron family of unmanned aerial systems (UASs). Selected for funding from the Binational Industrial Research and Development (BIRD) Foundation, the system will be demonstrated for the first time on the Heron medium-altitude, long-endurance (MALE) UAS platform in 2018. "Developing a sense-and-avoid system for our Heron UAS is a significant step forward in integrating MALE UASs into civilian airspace," said Joseph Weiss, President and CEO, Israel Aerospace Industries. "This collaboration demonstrates IAI's groundbreaking capabilities, innovation and technological development once again. We're excited to work with Honeywell, a leading company in avionics and safety systems, and view this effort as the first step in a series of cooperative efforts."

Flight testing will take place in Israeli airspace. Both companies plan for the full sense-and-avoid solution to be integrated into the Heron family of MALE UASs. In the near term, the work will set the foundation for safe operation and integration of unmanned aircraft in civilian airspace and will contribute to policies and procedures allowing for certification of avionics and platform systems.

Leonardo's M-346FT

Leonardo-Finmeccanica arrive with new name and colours !

Leonardo-Finmeccanica was a key exhibitor with a new profile, result of the "deep reorganisation" of the company undertaken by the CEO and General Manager Mauro Moretti.The new name 'Leonardo' and the new logo are symbolic of this change and presented for the first time at the Farnborough International Airshow. As below, there was a large static display area exhibiting their helicopters (various configurations includingthe AW189, AW159, AW149, AW 169 and AW101), a mock-up of the T-100 for the US, based on the advanced M-346 trainer, as well as unmanned aircraft such as the Falco EVO for fixed wing, and the SD-150 Hero, rotary wing, specialised in surveillance missions.

Gone are the red trademark colours of Finmeccanica that visitors are used to seeing at airshows worldwide–now replaced by the sober blue and white of the newly renamed company: Leonardo!

The Aermacchi M-346FT aircraft of Leonardo-Finmeccanica made its official debut at the show. The trainer is the multi-role version of the M-346 whose aim is to pass very easily from the trainer aircraft configuration to the operational mission. Based on the advanced trainer M-346, the FT (Fighter Trainer) variant integrates a wide range of systems and sensors for tactical support and air defence, a tactical data link, a self defence system, recognition and targeting sensors and a series of weapon systems.

New aircraft at FIA with Rockwell Collins technologies

At Farnborough 2016 were a broad array of next-generation commercial and military aircraft that featured major advancements in flight technology created by Rockwell Collins.The company's large-format, high-resolution displays allow a pilot to customise the information they want and need for flight. Cursor control devices and touchscreen technology on primary flight displays featured on these aircraft are 'signs that pilot interaction with the avionics continues to mirror the consumer world'.Rockwell Collins' Head-Up Guidance and Helmet Mounted Display Systems place critical flight information on displays directly in front of pilots' eyes—either on a glass mounted to the windshield or even on the glass of a fighter pilot's helmet.

Rockwell Collins avionics on the KC-390 flight deck.

Enter, Russia's MC-21 airliner

On 8 June, Russia made a significant effort to return to the narrowbody airliner market with the rollout of its new MC-21 airliner prototype at Irkutsk, East Siberia, the first narrowbody type developed in the country post-Soviet era. This is the baseline MC-21-300 variant, with a maximum take-off weight of 79,250 kg able to carry up to 211 passengers for a distance of up to 6,000 km. Assembly of the first prototype of the smaller MC-21-200 variant with 72,560 kg MTOW will begin next year. With an 8.5 meter shorter fuselage it will accommodate up to 165 passengers, but will have a longer range of up to 6,400 km.

The MC-21 is the most advanced civil aircraft that Russia has ever built. It will feature a high-aspect-ratio composite wing of supercritical profile that, according to the designers, will improve its aerodynamic efficiency in cruise flight. The composite components also include the wing box, and vertical and horizontal fins.

Visitors were offered a glimpse of its flight deck via a procedures trainer, which featured the avionics suite installed at the first aircraft including multifunctional 9x12-in displays, electronic flights bags and enhanced vision and synthetic vision systems, as well as components supplied by foreign manufacturers such as Honeywell, Thales and Elbit Systems. The most important foreign contribution is the aircraft's powerplant; it is powered by the 31,000-pounds-thrust Pratt & Whitney PW1400G-JM turbofan which was certified by the Federal Aviation Administration in May 2016. The first flight is planned for the early 2017, while Russian certification with the PW1400 engines is scheduled for 2018, followed by EASA approval a year later.

Part of the UAC stand at the show

BAE Systems working on 'Advanced Hawk' for India

BAE Systems state that the Hawk continues to evolve, with the latest T2 aircraft coming off the final assembly line in Warton bound for Saudi Arabia and Oman representing the aircraft's most advanced configuration. Work is underway with customers and industry partners in India to develop a combat-ready version of the widely used trainer that will be unveiled early next year."The latest export-standard Hawk is about 90% different from the T1 standard we've been successfully selling for the last 30 years or so," stated Philip Hodge, BAE's Hawk support and training business development director. "The Saudi Hawk is pretty much the baseline for the current export standard."


The Hawk trainer displayed outside the BAE Systems pavilion at the show

Discussions are ongoing with BAE's partner in India, Hindustan Aeronautics Limited (HAL), and the Indian Ministry of Defence towards introducing and displaying a new configuration, dubbed Hawk Mk132+at the next Aero India airshow to be held at Bangalore in February 2017. Options include a large-area cockpit display, support for helmet-mounted cueing systems, a slatted leading-edge to the wing to improve combat performance and an ability to carry weapons to provide a close air support capability.

Lockheed Martin at Farnborough

The Lockheed Martin F-35B got pride of place in a flypast with the Royal Air Forces Red Arrows display team on opening day of the Farnborough Airshow.

Denmark-based Terma and Lockheed Martin confirmed opportunities for Terma to pursue additional component production beyond their current contracted agreements for the F-35 Lightning II Joint Strike Fighter, following Denmark's recent decision to acquire 27 F-35As for their next fighter aircraft. Terma President and Chief Executive Officer Jens Maaløe and Lockheed Martin Aeronautics Executive Vice President Orlando Carvalho were on hand for the ceremonial confirmation of an agreement that allows for continuation of existing opportunities for Terma to provide best-value composite and bonded assembly work for the F-35 beyond Low Rate Initial Production and through full-rate production.

In 2013, Terma entered into a long-term agreement with Lockheed Martin for the manufacture of composite and bonded assembly parts for all variants of the F-35. The Danish company has also signed additional agreements for F-35 work with Northrop Grumman Corporation, BAE Systems, General Dynamics, and Marvin Engineering. Terma has been collaborating with Lockheed Martin since 1976 with the F-16 program and since 2000 as a partner on the F-35 programme. Terma's involvement in the F-35, since Denmark entered the program in 2002, comprises eight different production programs within advanced composite structural parts and electronics. To date, Danish industry has received orders in excess of USD 325 million.

Executives at the unveiling ceremony

Lockheed Martin unveiled a European-built Sikorsky Black Hawk helicopter at the Farnborough International Airshow, showcasing the types of weapons that can be integrated onto the multirole aircraft. Armed external wings on either side of the displayed aircraft feature a total of four weapons stations, with launchers for a mix of air-to-ground missiles, a 19-shot Hydra-70 rocket pod, and an FN Herstal Belgium-manufactured rocket/machine gun pod. For laser designating of a future weapons system as well as intelligence, surveillance and reconnaissance missions, the aircraft's cockpit chin features Lockheed Martin's Infirno sensor system.

Now a Lockheed Martin company, Sikorsky can configure an armed helicopter to the specific preferences of current and future customers. Sikorsky and its subsidiary PZL Mielec also signed a memorandum of understanding with PolskaGrupaZbrojeniowa (PGZ), one of the largest defence groups in Europe, under which PGZ companies would have significant involvement in the S-70i Black Hawk helicopter programme if Sikorsky and PZL Mielec are selected by the Polish government for multirole helicopters.

The agreement confirms Lockheed Martin's position as "a trusted partner for Poland's national defence." It has the potential to extend Lockheed Martin's involvement with Polish industry to include PGZ companies in the development and test of other armament for international Black Hawk helicopters and the supply of components and assemblies for aircraft and other products manufactured by Sikorsky and PZL Mielec. PGZ will support the multi-role S-70i Black Hawk helicopter in Poland as well as potential export markets in Central and Eastern Europe, the agreement, of course, subject to a decision by Poland's government to procure Black Hawk helicopters, which are produced at PZL Mielec.

Bravo !

Meanwhile, Bravo Industrie LLC of Brazil announced purchase of 10 LM-100J Super Hercules commercial freighter aircraft from Lockheed Martin. Bravo's Logística division, which consists of Bravo Cargas and Bravo MRO (maintenance, repair and overhaul), will operate the LM-100J for air cargo operations in Brazil, and include scheduled and route-specific solutions (same-day, next-day) as well as special cargo handling (heavy, odd-shaped, hazardous, refrigerated, etc.) and custom operations. Orlando Carvalho, executive vice president, Lockheed Martin Aeronautics said "like the C-130J on which it is based, the LM-100J is built to go where other aircraft can't,

The Lockheed Martin F-16 : Viper with a sting!

Lockheed Martin's Randy Howard, Director of F-16 Business Development

Despite an F-16 production backlog of only 15 aircraft, due to be completed toward the end of 2017, Lockheed Martin's Randy Howard, Director of F-16 Business Development, is confident in the type's future, owing primarily to the existence of the current-generation F-16V model. The F-16V is an upgrade programme for now, aimed at dozens of nations currently operating various models of the base aircraft, but the F-16V specification – primarily centred around a Northrop Grumman AESA radar and an improved cockpit layout – is also set to be the baseline for any new production orders. Any production orders for new-build F-16Vs would see the type given a formal 'Block 70/72' designation. Three undisclosed customers have already ordered upgrades for over 300 legacy F-16s between them, and discussions for new-build aircraft are also underway with other nations.

Talk of new-build F-16Vs is particularly relevant to India, given Lockheed Martin's strong push to establish an F-16 line in India to meet not only IAF needs but also the global spares and support market for the product. Company CEO Marillyn Hewson was in New Delhi the week before Farnborough 2016, to re-affirm Lockheed Martin's commitment to the Indian government's 'Make in India' policy and the national skill development initiative, and to expanding its business footprint in the country. Lockheed Martin already sources a significant portion of aerostructures for the C-130J transport and S-92 helicopter from India.

don't and won't. The LM-100J is the only commercial freighter that can fully meet the varying demands of the Brazilian market. Bravo is the ideal operator to introduce the LM-100J's unmatched capabilities in this pivotal region of the world."

The LM-100J is the civil-certified version of Lockheed Martin's proven C-130J Super Hercules aircraft, the first currently in production and to undergo an FAA type certificate update prior to delivery in 2018. Through select design innovations, the LM-100J will perform as a commercial multi-purpose air freighter capable of rapid and efficient cargo transport.The LM-100J incorporates technological developments and improvements over the existing L-100s that result from years of military C-130J operational experience, including more than 1.3 million flight hours by operators in 16 nations. The result of this experience and advancement translates to an aircraft that will deliver reliable service in a multi-role platform for decades to come.

Bravo purchased 10 LM-100J commercial freighters

The Boeing aircraft types at Farnborough 2016 included the ANA 787-9 Dreamliner, 737 MAX, P-8A and F/A-18E Super Hornet (pictured on left).

Boeing celebrates Centennial

Boeing celebrated its centennial amid a highly successful 2016 Farnborough International Airshow that saw multi-billion dollar orders and commitments across the company, including defence platforms, commercial airplanes and services agreements. “As the birthplace of British aviation, there are few better backdrops to celebrate the accomplishments and wonders of the aerospace industry and mark our centennial than the Farnborough Airshow,” said Boeing Chairman, President and CEO Dennis Muilenburg. "Throughout the show, we demonstrated and discussed our innovative and cost effective products and services and the tremendous value they provide our commercial and defense customers. The British government announced significant orders for Boeing defence equipment. At the same time we committed to doubling Boeing presence in the UK in line with the government's Prosperity agenda and our global growth strategy for the second century. On the commercial side of the business, we were pleased at the confidence our customers displayed in our portfolio of airplanes and services with significant orders and other announcements,” Muilenburg said.

A total of 182 Boeing commercial airplanes, valued at $26.8 billion at list prices were ordered. Customers also announced commercial services agreements valued at multiple billion dollars over the life of the contracts, including the largest commercial services order in Boeing history.

The UK Ministry of Defence announced a $2.3 billion deal to secure 50 Apache AH-64E helicopters and confirmed the purchase of nine P-8A Poseidon maritime patrol aircraft for the Royal Air Force (RAF). Boeing and the British Government also announced a long-term partnering initiative to advance growth and prosperity, including 2,000 new Boeing jobs to be created in the UK, the intent to build a new £100 million ($135 million) P-8A Poseidon facility at RAF Lossiemouth, increased Boeing capital investment in the UK and additional bidding opportunities on Boeing programs for UK suppliers.

The Boeing Legacy - at Farnborough

Boeing celebrated 100 years since its founding on 15 July 1916, marking a “legacy of connecting and protecting people and nations, exploring Earth and space, and inspiring dreamers and doers alike through its products and services”.

The Boeing chalet marking 100 years

Since starting out as a builder of wood and fabric floatplanes in a Seattle boathouse, Boeing has become the world's largest aerospace company and leading manufacturer of commercial jetliners and defence, space and security systems. "The innovative spirit of our founder Bill Boeing — who 100 years ago today dedicated this company to building something better — is alive in the generations of our people who continue to deliver products and services that matter and positively change lives around the world," said Boeing Chairman, President and CEO Dennis Muilenburg. "As we embark on our second century, our commitment to excellence is stronger than ever, our potential for achievement is as great as it was for our founders, and our goals must be even more bold, visionary and inspiring."

The Boeing of today represents a number of major companies that have merged over the past century, including McDonnell Aircraft, Douglas Aircraft, North American Aviation/Rockwell, Piasecki/Vertol, Howard Hughes' helicopter and space companies, Stearman and The Boeing Companyitself. The legacy of those aerospace companies reflects products such as the 7-series jets, including the first successful commercial jetliner, the 707; the Douglas DC jets, Douglas World Cruiser, C-47 Skytrain and A-4 Skyhawk; the North American B-25 Mitchell, P-51 Mustang, F-86 Sabre Jet, F-100 Super Sabre, B-1B Lancer and X-15; the McDonnell F-4 Phantom II, McDonnell Douglas F-15 Eagle, C-17 Globemaster III and F/A-18 Hornet; the CH-47 Chinook, AH-64 Apache and V-22 Osprey; the B-17 Flying Fortress, B-29 Superfortress, B-47 Stratojet, B-52 Stratofortress and KC-135 Stratotanker; the Saturn and Delta rockets and Gemini, Mercury, Apollo, Space Shuttle and the International Space Station!

The Boeing Centennial Experience Pavilion, of 5,000+ sqft immersive showcase of innovation leadership past, present and future, welcomed nearly 5,000 visitors over the first four trade days of the show.

While Embraer and Boeing announced a teaming agreement to jointly market and support the KC-390, Boeing flying display highlights included the ANA 787-9 Dreamliner and 737 MAX, P-8A and F/A-18F Super Hornet.

Boeing released its annual Current Market Outlook (CMO) on the first day of the event, estimating the total value of new aircraft at $5.9 trillion. Boeing projects a demand for 39,620 new aircraft over the next 20 years, an increase of 4.1 percent over last year's forecast. "Despite recent events that have impacted the financial markets, the aviation sector will continue to see long-term growth with the commercial fleet doubling in size," said Randy Tinseth, vice president of Marketing, Boeing Commercial Airplanes. "We expect to see passenger traffic grow 4.8 percent a year over the next two decades."The single-aisle market will be especially strong, with low-cost carriers

Volga-Dnepr have ordered 20 747-8 Freighters

and emerging markets driving growth. 28,140 new airplanes will be needed in this segment, an increase of more than 5 percent over last year.

Boeing and Volga-Dnepr Group announced finalisation of terms for the acquisition of 20 747-8 Freighters, which includes four aircraft that have already been delivered. Boeing also signed an agreement with the Group's subsidiaries AirBridgeCargo Airlines and Volga-Dnepr Airlines to provide long-term logistics support for Boeing Commercial Airplanes and its partners using Boeing 747-8 and Antonov 124-100 freighters.

Boeing: India has "market, productivity, talent"

At Farnborough 2016, Boeing Defence, Space and Security (BDS) hosted a roundtable discussion with select Indian media, including *Vayu*, where Shelley Lavender, President Boeing Military Aircraft, and Gene Cuningham, BDS Vice President for Global Sales and Marketing, spoke at length on Boeing's plans in India, the Company having "done business in India for 70 of its 100 years."

Shelley Lavender, President Boeing Military Aircraft

In fact, Shelley Lavender visited Tata Advanced Systems (TASL) on 15 July last year – the first day of Boeing's 100th year – to sign an agreement on a strategic aerospace partnership (*see Vayu IV/2015*), and said that the timing of that event and the celebration of Boeing's centennial at Farnborough "made her nostalgic." The agreement signed then bore fruit shortly thereafter, with Tata and Boeing announcing a partnership to produce Apache fuselages in Hyderabad in November that year (*see Vayu VI/2015*).

Lavender noted that that although Boeing Defence has only operated in India for about a decade, the growth in business in that period has been rapid. She highlighted BDS' on-going partnerships in the country, not just high-profile JVs such as the one with Tata, but also integration of smaller firms such as Dynamatics and RossellTechsys into Boeing's global supply chain. She stressed that point as a key part of Boeing's offer of the F/A-18E/F Super Hornet to India, saying that Boeing was keen to build an industrial ecosystem around production of that aircraft in India.

According to Lavender, Boeing looks for "certain parameters" when doing business and making investments around the world – there needs to be a market, an industry that "provides productivity, affordability and creates value," and local talent. "I can tell you, for the military side, India hits on all three of those," she summed up with a smile.

Boeing is already well away with the Apache aerostructures venture, with engineers in Hyderabad designing their own jigs and tooling for fuselage production, bringing in fresh ideas for efficiency and value in manufacturing.

The Super Hornet offer hopes to replicate this, starting with kit assembly in country, with initial focus being on developing local competencies in project management, contractor management, quality assurance and flight testing, as a local ecosystem grows alongside. By the time production is done, the plan is to have a true 'Make in India' fighter, leveraging Boeing's "state of the art" production processes from across its commercial and military portfolio. Boeing's Super Hornet backlog extends "out into the 2020s" according to Lavender, making the offer more than a simple transfer of an idle production line to India. She confirmed that Indian production of the Super Hornet would proceed alongside manufacturing in Boeing's St Louis facility. Lavender stressed that Boeing was willing to make the investment into producing Super Hornets in India because it saw the opportunity as "a win-win" for both parties.

Angad Singh

Of particular Indian Interest

The Indian tri-colour was amongst scores of those of various nations fluttering on flagpoles at the entrance to the Show and well it should it have as there was Indian presence at Farnborough 2016, both of the public (Hindustan Aeronautics Limited) and private sectors (Tata's, HCL and others).

Whilst the latter had large stands in the Halls, showcasing India's IT prowess, HAL had its now customary double chalet in Row 'K', at the virtual end of the Show space and somewhat difficult to find for visitors unless they have a GPS ! The large interior was uncluttered but wafts of curry smell would certainly have got visitors salivating as they conducted one-on-one meetings with HAL senior executives, led by the CMD Suvarna Raju and including Mr DK Venkatesh, Director (Engineering and R&D), Mr Daljeet Singh, CEO Nasik Division and Mr Rajiv Kumar, CEO Accessories Complex at Lucknow and other executives.

There was not much evidence of HAL's aircraft except for some video films and posters even though HAL certainly have some interesting products to offer the world market including the Dhruv ALH, the Dornier 228 LTA and soon enough, the LCH and LOH. At past Farnboroughs', HAL has displayed and flight demonstrated some of their aircraft including the Dhruv ALH and HJT-36 IJT (the latter at Le Bourget in Paris) and hopefully next time around, will have real aeroplanes flying at this real Air Show (and not only at the somewhat obscure Bahrain event).

The official Indian delegation was led by Air Marshal RK Dhir, AOC-in-C SWAC and included Mr Kamlesh K Pant, Joint Secretary (Aerospace), and Mr Anil Shrivastava, Joint Secretary, Ministry of Civil Aviation. The recent Indian Cabinet reshuffle meant that Rao Inderjit Singh, erstwhile Minister of State for Defence did not come to the Show this time, nor did the 'Make in India' seminar planned by the

Mr DK Venkatesh, Director (Engineering and R&D) and Mr Rajiv Kumar, CEO Accessories Complex during meetings at the HAL Chalet

CII take place on Day 3 and the organisers were reportedly content to hold an evening reception (in town).

But there were many areas of interest for Indians at Farnborough 2016 and *Vayu*, which had just been honoured at the pre-Show event at the Royal Aeronautical Society headquarters (*see separately*), had its editorial team fan out throughout the Show to interview, report and record on some of these aspects.

Air Superiority

Major General Mats Helgesson, Chief of the Swedish Air Force speaking at the event marking integration of Meteor with the Gripen.

Certainly, the most prominent presence at Farnborough 2016 was that of the Swedish Defence and Aerospace Company which presented their 'Saab Experience' in an enormous structure at the centre of the Farnborough site outside of main exhibition halls and the mid-point of the static display areas.

L-R : MBDA CEO Antoine Bouvier, Maj Gen Mats Helgesson and Saab CEO Håkan Buskhe

On the very first day, Saab had Chief of the Swedish Air Force and Chief Executives of Saab and MBDA on stage to speak on official entry into service with the Swedish Air Force of the Meteor beyond visual range air-to-air missile (BVRAAM). Sweden's Gripens are the world's first combat aircraft to deploy an operational Meteor as part of Gripen's MS20 capability upgrade, "a game changer".

Over the next days, Saab gave programme updates on the first Gripen E, its GlobalEye airborne surveillance system, its Remote Tower Technology and the Digitalised Airport, the latter being of much pertinence to the Indian civil aviation sector with emphasis on expansion of rural air links as per the new civil aviation policy (*see separately*). However, it was the civil airliner giants that grabbed most of the headlines with massive orders for new airliners announced and a happy birthday party as Boeing celebrated its centenary.

Airliner Sales

Airbus announced $35 billion worth of business for a total of 279 aircraft, both single-aisle and widebody aircraft families, including A320neos to GoAir and Air Asia. In the widebody segment Airbus won firm

Tony Fernandes of Air Asia with Fabrice Brégier, President Airbus, backdrop provided by colourful cabin crew

orders for 10 aircraft worth $3.4 billion comprising two A330-300s and eight A350-1000s. In addition to these new widebody orders, the Show also saw the launch order from DHL Express for the A330-300 Passenger-To-Freighter conversion programme, in partnership with EFW and ST Aerospace.

Boeing celebrated its centennial at Farnborough with its impressive 'Centennial Experience Pavilion', having an immersive showcase of innovation leadership past, present and future. As the Boeing Chairman,

Mock up of the Gripen E with its range of weaponry, including the Meteor

President and CEO Dennis Muilenburg exulted, "as the birthplace of British aviation, there are few better backdrops to celebrate the accomplishments and wonders of the aerospace industry and mark our centennial than the Farnborough Airshow". He had good reason to be cheerful with the British Government announcing significant order for Boeing Defence Equipment on the very first day : 50 Apache AH-64E helicopters and nine P-8A Poseidon maritime patrol aircraft for the Royal Air Force (RAF). On the commercial side, there were orders and commitments for a total of 182 Boeing commercial airplanes.

British Prime Minister David Cameron (till next day), seen with aircrew and other personnel at the Boeing P-8 on display at Farnborough 2016

On Home Ground

On home grounds, with BAE Systems headquarter buildings a cricket ball throw away from their Farnborough Air Show exhibits, these were showcased within the FIVE building at the far end of the chalet line, with a full-scale replica of the Eurofighter Typhoon acting as the centrepiece. This was similar to the Phase 3 Enhancement-representative aircraft that BAE test pilot Nat Makepeace flew with thunderous precision during the daily flying display with an expanded fit of air-to-air and air-to-surface weapons.

After its 'no-show' at Farnborough 2014, it was the F-35 that grabbed many of the headlines this year. While the Lightning II is of Lockheed Martin origin, its appearance is of huge significance to BAE, which provides around 15% of each aircraft produced through its Military Air & Information and Electronic Systems business units.

"We are a principal subcontractor on this programme and bring military aircraft expertise that is critical to the F-35 Lightning II airframe, systems and sustainment," said CEO, Ian King in an

The 'thunder' of the Eurofigher is provided by the EJ 200, seen in Eurojet's stand in Hall 4 at Farnborough

earlier interview. "We currently employ around 1,800 people on the programme at various locations across the UK, the USA and Australia. Our advanced manufacturing site in Samlesbury, Lancashire, produces the aft fuselage and vertical and horizontal fins for the whole programme, and a further £100 million [$129 million] investment is being made in manufacturing capability in readiness for increased production rates.

"Our team in the USA provides the electronic warfare suite for the F-35, which includes fully integrated radar warning, targeting support, and self-protection, to detect and defeat surface and airborne threats. BAE Systems Australia also manufactures vertical tail components, and has been assigned the F-35 airframe sustainment role in support of the global F-35 fleet in the southern Pacific."

Among the other highlights at Farnborough 2016 were BAE Systems latest human/machine interface technologies for

Mock up of the F-35 was of huge interest (C-27J of the US Coast Guard at back)

pilots, including revealing a notional ground control station and simulated mission scenario for a future combat air system (FCAS), which could enter operational service around 2035. Describing the Anglo-French FCAS project as "progressing very well", Mr King said : "In March we welcomed the announcement by the governments of a new €2 billion [$2.2 billion] project to build an unmanned combat air system demonstrator. This will secure high-end engineering jobs and is anticipated to be contracted in 2017. The very welcome funding will be significant in developing autonomous capability and technologies which will benefit both the UK and France."

Travails of India's regional airliner project

This subheading summarises it all : Since the early 1970s, various entities of the Indian Government have reviewed the requirement to air connect tier 2 and 3 cities across the vast subcontinent and committees after committees have given in recommendations for either selecting an existing commuter/utility aircraft or indeed developing one in-country. This is a subject which could fill an entire issue of *Vayu* (and indeed will in the near future) but for the present, some aircraft which were displayed at Farnborough 2016, and indeed notched numerous successes, are reviewed.

On display were two examples of the Dornier 328 JET and its turboprop predecessor, both of which types could well have been manufactured in India by HAL as a follow up to the eminently successful (and ongoing) Dornier 228 programme. Alas, the powers that were did not continue the relationship and the logical, and larger, 328 went to other hands in 2002. Recently, the 328 programme has been taken over by TRJet and adopted by the Turkish industry which has ordered an initial 10 TRJ328 aircraft while a Singapore party has ordered 5 of the TRP328 version for special missions. The 328 and its derivatives have a long future ahead and India can only rue on what could have been !

Decades after the HAL-Dornier programme went under way, and the tantalizingly close 728/928 new generation regional jetliner family programme did not find a home in India, the Canadians, Japanese and Chinese industries continued their own development programmes with

Inside out ! 328 turboprop taxis at Farnborough 2016 with its intriguing paint scheme

the result that, today, the C-Series, MRJ and ARJ 21 respectively are on the cusp of world market penetration. At Farnborough 2016, the Chinese COMAC announced deals for 90 ARJ 121s, 60 of them for Friedmann Pacific Asset Management and 30 more for Avic Leasing. The ARJ 21 entered service in June with Chendu Airlines *(see Vayu III/2016)*.

Meanwhile, destined for much success is the Sukhoi Superjet 100, the first of which will go into service in Europe with Ireland's CityJet, and was on static display at the Show. *Vayu* was invited by UAC's Maxim Syssoev to examine the cockpit and interior of the aircraft at Farnborough. The aircraft for CityJet is in the 98-seat configuration with exclusive interior designed by Pininfarina, five abreast seating in a generous 32" seat pitch. Currently there are about 80 SSJ100s in service with customers. The aircraft in service operated more than 205,000 flight hours totally for more than 140,000 revenue flights.

India's National Civil Aviation Policy 2016, which was formally announced less than a month before Farnborough 2016 (*see separately*), has key goals for India to become "the third largest civil aviation market in the world by 2022". Thrust is on regional air connectivity and the choice of airliner types for Indian operators increases all the time.

HAL is reportedly examining options for a regional airliner programme to meet the expected requirements for over 100 aircraft of 50-80 seats. One aspirant could well be the Ilyushin Il-114-300 of 64 seats, presently powered by 2 TV7-117SM engines but this basic design has potential for major upgrading with western engines and a glass cockpit. For the latter, the Samtel-HAL joint venture could well be considered. Meanwhile, the HAL-Ilyushin multirole transport aircraft (MTA) programme, subject of an inter-governmental MoU awaits the green signal for a go ahead, which hopefully will see the actual aircraft perform in a future Farnborough Air Show.

Mock up of the COMAC ARJ21 at the Chinese stand in Hall 4

PSC

Mr Puneet Kaura, CEO of Samtel Avionics with Vladimir A Belyakov of Ilyushin (a UAC company) at the Farnborough Air Show

The glass cockpit of Sukhoi's Superjet 100 at Farnborough 2016

SAFFC Celebrates Golden Years

On eve of the Farnborough Air Show 2016, it was 50th anniversary of the Swedish Air Force Fan Club (SAFFC), held at the now traditional venue, the Royal Air Force Club, Piccadilly in London (with an equally appropriate location in the heart of Paris every alternate year). This unique institution was, in fact established in September 1966, an 'inspiration' of four legendry British aviation writers, each of whom left behind an amazing legacy for millions of aviation enthusiasts and professionals alike.

Genesis of the SAFFC goes back to a visit by select British journalists to Sweden in the summer of 1965. These were William Green and Gordon Swanborough, whose annual 'Observers' books enthralled generations and which pocket-sized books became the 'bible' for the aviation world. They wrote scores and more of aviation books including the definitive 1,000-page magnum opus on *Warplanes of the Third Reich* and so much else. They were also founding editors of the renowned monthly *Air International*, which continued the lineage of the *Flying Review International*, whose content and style has often been emulated but never surpassed.

The other two British writers were equally acclaimed John Taylor who was virtually synonymous with the annual *Jane's All the World's Aircraft,* and John Fricker, former RAF fighter pilot and later prolific writer on aviation matters including *Battle for Pakistan*, which was the (Pakistani) account of the air war of September 1965 (Pushpindar Singh, who was invited to be a member of the SAFFC in the late 1960s and therefore now arguably one of its senior most members, recalls many animated, but never acrimonious, discussions with John on his 'prejudiced' views, but that is another story !).

The Swedish Air Force and its 'fans'

When those British aviation journalists visited Sweden in the spring of 1965 the Swedish Air Force had moved on from flying Saab's J-29 Tunnan ('Flying Barrel') to the J 32 Lansen and then the J 35 Draken even as the revolutionary J 37 Viggen was at the development stage (this type was actually selected by the Indian Air Force to meet its DPSA requirement in the mid-1970s till a US embargo on its power plant scuttled induction). Continuing the lineage, the lighter weight, but incredibly cost effective new generation JAS 39 Gripen was to follow in the early 1990s and this type is presently the subject of immense interest in India.

But we are racing far ahead of time.

On return from their visit to Sweden in 1965, the British journalists were an amazed lot. They had written admiringly, or talked on television about the Swedish fighters, including the types named above, which was hardly surprising. They were intrigued as to why Sweden was not following the more conventional forms adopted by combat aircraft designers worldwide. In any case, the observers could well wonder what was the sense of such modest numbers of home-produced fighters in a neutral country that rejected nuclear weapons, but was on the door-step of a superpower.

One week after their visit to Sweden, they knew of the reasons and that to many other questions which had never entered their minds in England. They visited factories where every major component of the Viggen was being developed, tested and built: Volvo Flygmotor at Trollhattan (catching fish from a boat cruising at a leisurely pace up Sweden's west coast on the way), Saab at Linköping (including the first sight of a modern underground factory), AGA, Ericsson—makers of aero-engines, airframes, ejection seats, radar, avionics—the entire infrastructure. At every step, detailed briefings explained precisely why the Viggen was taking shape the way it was. Most significant of all was a briefing by the Chief of the Swedish Air Force on how the new fighter would form a key part of the nation's future defence strategy. By the end of the briefing, they were all convinced that the Viggen was precisely correct for its intended role in a completely realistic policy. Visits to the Bloodhound missile wing at Barkarby and the fighter base at Nörkoping provided an impressive glimpse of the air force that would fly the Viggen. After a simulated combat sortie, a Draken landed on a highway, went to dispersal, rearmed, refuelled and was cleared for take-off in eight minutes.

Swedish hospitality and openness made the six hectic days a delight. A paragraph in the Preface to the 1965-66 edition of

Jane's All the World's Aircraft commented: "Sweden ... considers it un-avoidably necessary to develop the Viggen combat aircraft, even if no export market will ever be found for it. This is part of the high price of strict neutrality combined with a unique defence problem".

But how could the by now well-informed British journalists monitor progress on the Viggen and Sweden's developing defence strategy? The answer lay in approaches to the right people, a concept which gave rise to the *Swedish Air Force Fan Club*. So began the now traditional annual reunion dinners during the Farnborough and Paris Air Shows, always with a briefing by successive Air Chiefs, 'real' flying people, who answered questions honestly and professionally. No other air force has had the imagination to form such a Fan Club, whose members feel almost a personal pride in the success and superb safety record of the Viggen and those who flew them.

Some decades later, in September 1994, a large and mixed party of international journalists was invited on a four-day visit as guests of the Swedish Air Force and industry. Highlights included a visit to the Swedish air base at Såtenäs where they were face to face with the first Gripens, this new generation multi-role combat aircraft having just gone into operational service. Not to forget a surprise visit to the Island of Visby where their SwAF Hercules was escorted in by a pair of Viggens. Later, to a stretch of highway road base where a Viggen landed, was rearmed, refueled and took off within eight minutes. The next generation Gripen does this even better !

Running the Club

Since the beginning of the 1970s, chairmen of SAFF have been the Chief Press Officers of the Swedish Air Force. Ulf Bjorkman was first and was succeeded by equally distinguished personalities including Owe Wagermark, who is the present Chief of Staff to CEO of Saab. In 2006, Mats Gyllander became chairman of SAFF, a position he still holds with aplomb and was responsible for the latest function of the Swedish Air Force Fan Club in London on 10 July at the RAF Club where the present Swedish Air Force Chief, Major General Mats Helgesson spoke about current status of his force and the challenges faced. He was followed by representatives of the Brazilian Air Force which is going to be the first international operator of the new generation Gripen, the E/F.

It is in fitness that we reproduce the memoir's of one of the great fans of the Swedish Air Force whom this writer first met during the memorable visit to Sweden in September 1994, the irrepressible Robert Hewson.

No other Air Force

I am pretty sure that there's no other air force out there with its own fan club. I am also pretty sure that there's no other air force that really deserves one. The Swedish Air Force Fan Club is a very special creation, one that was born before I was—but I know exactly why it exists. The SAFF sprang out of the amazement and incredulity that a group of aviation journalists experienced when they first visited Sweden in the mid-1960s. Hidden away in a quiet little corner of northern Europe was a country like no other, with an air force like no other, with aircraft like no other and an entire aerospace industry like no other.

Sweden has developed not simply aircraft, but tactics, doctrine and an entire philosophy that is utterly unique. The Swedish Air Force planned to fly and fight in a way that no-one else had really considered — but it was clearly the only way to win.

"No other fighter... !"
Gripen in full afterburner

Datalinks, networks, off-board sensors, distributed C4I, dispersed operations from austere bases - all common currency in the Swedish Air Force but revolutionary elsewhere in the world. I am sure that those visitors 50 years ago, and since, were astonished because Sweden had never bothered to say much to anyone outside the country about what was going on there. Maybe it was Swedish modesty, or perhaps it was the fact that a lot of people in Sweden didn't realise that they were so far ahead.

I was just as astonished when I came to Sweden for the first time in 1993. As I visited Air Force and industry facilities and marvelled at how they worked day-in and day-out, the question my hosts asked the most was, "isn't everyone doing this?" No they are not, was the answer, and that is as true today as it was in 1965. Sweden remains a power-house of new ideas and sensible thinking. *The Swedish Air Force Fan Club* plays a small but important role in explaining those ideas, and the whole Swedish way of doing business, to the wider world. The Club is in the privileged position of being taken seriously by the SwAF and, in return, the SAFF members are keenly interested in what the SwAF has to say. It's an interesting relationship, the journalists and the military, but like most things Swedish, it works. Perhaps the most important reason it works so well is that the SAFF, and the activities that surround it, is a great place to meet people and make friends. All the years after I first came to Sweden I'm still in touch with many of the people I met back then, plus all the others I have met since.

Some of them now run entire companies, and some of them now run the *Swedish Air Force! Through the Swedish Air Force Fan Club*, the Swedish Air Force has a unique forum to educate and inform, to set out its agenda and face the music. It's not a love-in, and questions are raised and articles are written that have upset the odd breakfast or two in Headquarters the next day —but by and large it is a meeting of two groups who speak the same language and respect what each other does. It's the kind of thing can that can only happen in Sweden and it's all the more delicious for that.

Happy Golden Jubilee SAFF !

40 years back...

Vayu's first Farnborough Show : 1976

The enigmatic Anglo-French Concorde supersonic airliner was the cynosure of all eyes at Farnborough 1976 (Vayu had earlier been specially invited to fly in the Concorde during one of its route proving flights between Bahrain and Bombay in 1975)

In fact, the first Farnborough International Air Show covered by *Vayu* was in September 1976, this just-launched journal having "missed" the very first by a few months. *Vayu* had been established in November 1974, few months after the debut of that show but its very first issue carried a report on the major event.

Some excerpts from the *Vayu* of October 1976 make for fascinating reading and an invaluable record of the times as filed by *Vayu's* then Technical Editor, Hormuz M Mama:

It is a ritual that is unfailingly performed every other year by the world's aerospace faithful who make their pilgrimage to an otherwise obscure part of England known as Farnborough. For eight glorious and hectic days, its hallowed grounds are transformed into the Mecca of the aerospace world.

It was two years ago that Farnborough went international with some show of understandable regret but a great deal more of realism on the part of the organisers. It would be wrong though to suggest that Farnborough will never be the same again. The change has only been one of scale. The Show now acts as the show-window to the industries of the world, while in the past it had features that of just one. British aircraft, in any case, continue to hold their own against the best from other countries and are in no danger of being overwhelmed by the competition.

While collaboration is the new name of the game, it has by no means been achieved at the price of individuality, and these sterling qualities that have made British aircraft so much sought-after, are as clearly conspicuous in the collaborative ventures as they were in the earlier independent designs.Indeed little of essence has changed over the years. Even the capricious British weather was the same—abruptly terminating Britain's severest draught in four centuries to keep its traditional appointment with Farnborough.

Farnborough 1976 demonstrated the inevitability of further collaboration among the aerospace manufacturers of the Western world, particularly among the commercial aircraft manufacturers. Even the Americans realise that they can no longer go it alone primarily for considerations of financing and market size – and this could lead to the coming together of some strange bedfellows. In the ultimate analysis though, it would be far better to come together and share the still considerable market than to cut each other's throats.

Some estimates place the commercial market at 3,000 aircraft worth $46 billion by 1985. The military market up to 1990 is estimated at 6,000 aircraft of all types, valued at $30 billion. All manufacturers are now unanimous on the point that the recession in the aerospace market is drawing to a long-overdue close. Also coming to an end is the so-called "decade of the derivatives" that compelled manufacturers to be content with offering only derivatives of existing aircraft rather than totally new designs. Those first off the starting line will win the biggest prizes.

While the British industry has some extremely competitive new products in the military market place, most of its commercial products are more than a decade old. Much of the industry's revenue today comes from the export of spares rather than complete airframes and this could have disquieting consequences as these older aircraft are inevitably phase out of service in the next few years. It is heartening to note that some new projects are finally around the corner and should be able to take over at just about the time sales from earlier aircraft finally begin to taper off.

This year's Show also gave several pointers to the shape of things to come-more so than on most previous occasions. Collaboration on major projects emerged as the "in thing" with even the titans Lockheed and McDonnell Douglas putting up the white flag to surrender their individuality. At the same time it became crystal clear that US manufacturers who have cornered over 85 percent of the non-communist world's commercial aircraft market, are

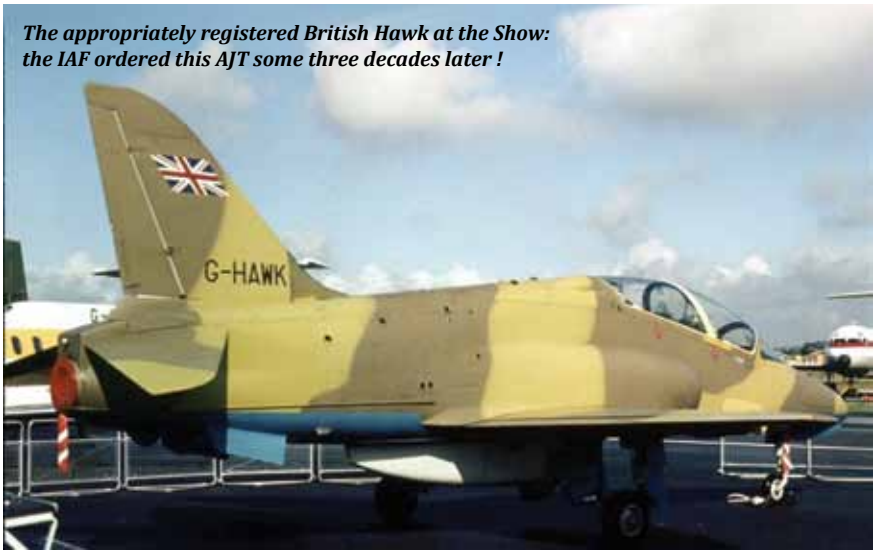
The Lockheed Tristar of Gulf Air at Farnborough Air Show 1976

Dassault-Dornier Alpha Jet A at the 1976 Farnborough Airshow: contender for the IAF's AJT requirement

in an excellent position to further enlarge their share. Europe will have to work very hard indeed to retain its present share of the market-leave aside to and the Americans seem to be the first off the mark with new projects as well as considerably rehashed versions of existing designs. The Tornado emerged as a shining example of what could be achieved through collaboration in the military field. Even in the US, the marriage of convenience between McDonnell Douglas and Northrop on the F-18 was a step in that direction.

Europe's disunity was all too evident at Farnborough with jet trainers forming the latest bone of contention on which to duplicate efforts and waste resources. The savage battle between the Hawk and Alpha jet has been joined by the CASA C.101, with older designs like the MB.329, Strikemaster and Saab 105 further complicating the situation. These resources could have been far better utilised by standardising on one or two types and better utilizing the available resources. This situation is not entirely unique to the European countries, as Farnborough proved. Present at the Show was the Polish Iskra–again a jet trainer-designed, developed, produced–and now exported despite immense Soviet pressure for standardisation around the Czech L-29 and L-39. This situation is repeated *ad nauseum* in almost every field wherever a large number of companies have acquired the necessary capability to complete. In the commercial aircraft field, European manufacturers fight each other far more than the "common enemy" across the Atlantic. This had led Mr Allen Greenwood, Chairman of British Aircraft Corporation, to sourly comment during a speech to the AECMA "We have quite enough competition from outside Europe without competing among ourselves." Despite the clear writing on the wall, Europe sadly continues to be fragmented in its approach to the aerospace field. Despite French unilateralism with the Mercure 200-a project which may yet die a natural death-Europe still has a chance to collaborate on sounder projects like the BAC X-Eleven, the HS.146 and the Fellowship follow-on. The Airbus also merits better support for the future. While European collaboration with US companies should always be welcome, they should not allow themselves to be reduced to the level of subcontractors.

Particularly worthy of mention are export achievements of the British electronics industry which has been performing near-



The appropriately registered British Hawk at the Show: the IAF ordered this AJT some three decades later !

miracles of ingenuity and resourcefulness. As an interesting example, Marconi-Elliot have won orders for the advanced digital fight control electronics system for the Boeing YC-14, the complete head-up display weapon aiming system for the F-16, the raster HUD system for the A-7E, the AQS-901 accoustic processing and display system for RAAF Orions, and more recently the AD620 system computerised navigation system for the MB.339. Examples such as these abound in the British electronics industry.

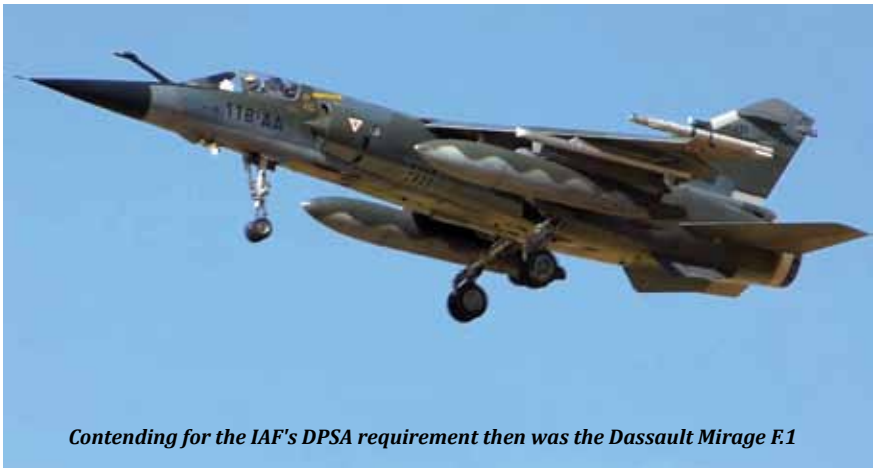
Outside the United States, but not excluding the Soviet Union no company has displayed a more wide-ranging capability particularly in the field of high by-pass ratio engines than Rolls Royce, a name that continues to be synonymous with aerospace perfection. Sales and performance figures for the RB.211 have confounded the optimists. Rolls Royce constitutes an asset that Europe cannot afford to ignore.

What made news at Farnborough 1976

★ The Royal Navy placed orders for its second *Invincible*–class anti-submarine cruiser which will be named HMS *Illustrious* while the name *Indomitable* has been allocated for the third such vessel. The first of twenty four HS Sea Harrier FRS.1s for employment on board these ships will be completed by mid-1977 and will initially enter service on board HMS *Hermes* in 1979. Besides India and Iran, which have maintained strong interest in the Sea Harrier, Peru is stated to be considering the Sea Harrier for operations off a light fleet carrier which is yet to be purchased.

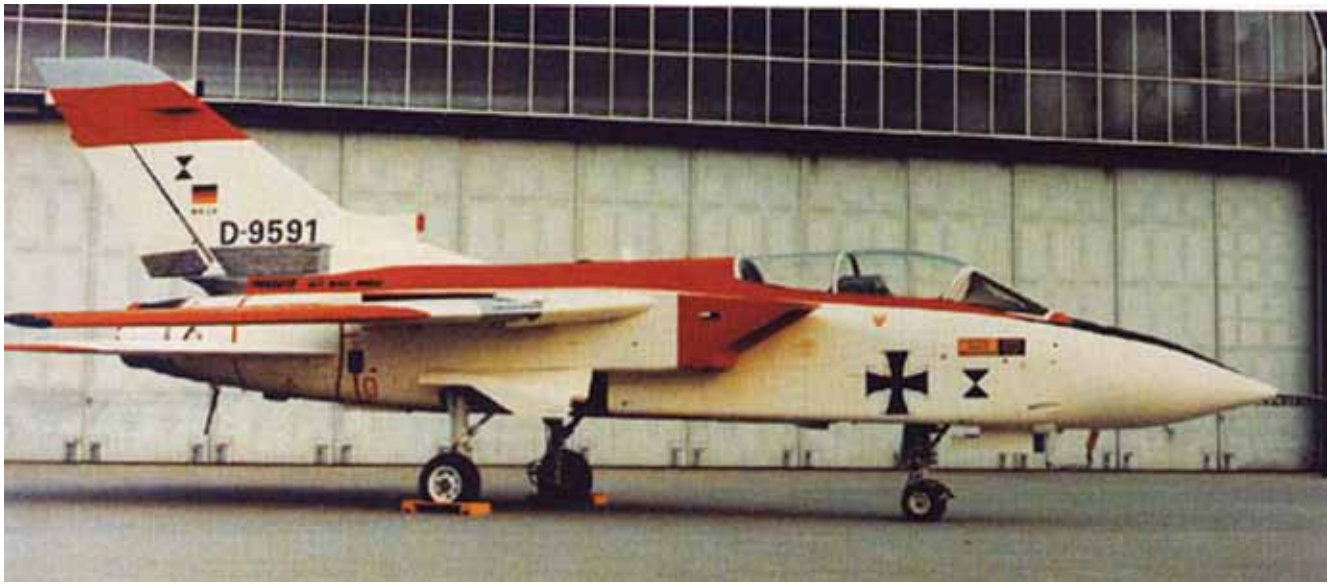
★ The Turkish Air Force has reportedly selected the Dassault-Breguet/Dornier Alpha Jet as its new advanced jet trainer and partial licence manufacture in Turkey is also envisaged. The first SE Asian nation to possibly procure the Alpha Jet will be Indonesia, whose air arm, once the strongest in the region and equipped with MiG-21s and Tu-16s, is now barely maintaining one squadron with ex-RAAF Sabres and a handful of piston-engined bombers.

★ The *Armee de l' Air* plans for the next decade, recently reviewed by their Chief of the Air Staff, state that a front line combat force of 450 aircraft will be maintained. By 1980, six squadrons will be operational on the Mirage F.1, and eight to ten will be equipped with the Jaguar. The remaining combat formations – 14 to 16 squadrons – will continue with the Mirage III/5 while the Mirage Delta 2000 is viewed as the future major combat aircraft type from 1984 onwards. The maiden flight of the first of three Mirage 2000 prototypes is



Contending for the IAF's DPSA requirement then was the Dassault Mirage F.1

The unique V/STOL Sea Harrier, soon to be ordered for the Indian Navy



The first of more than a dozen Tornado prototypes first flew in August 1974 at Manching, Germany: the proposed HF-73 would have been powered by similar RB 199 turbofans !

planned for 1978 and this type could be the lead-off for a long line of derivatives. The Mirage 2000 will be powered by the SNECMA M.53, the-7 version of which would develop a thrust of 10 tons.

★ The first prototype of the Air Metal AM-C 111, multi-purpose STOL transport, is nearing completion at Landshut, north of Munich in West Germany. The AM-C 111 has been developed after extensive market research which studied specific needs of the operator, the special feature of this advanced design being its quick change capability. The AM-C 111's versatility coupled with its performance characteristics make it attractive both for third-level air services as well as military communications and logistics support tasks.

★ The RAF view the Tornado as the most important combat aircraft in the nineteen eighties, with the service programmed to receive 385 aircraft which will serve in two basic versions – an interdiction strike (IDS) aircraft and air-to-air interceptor. In addition a fully operational version with dual controls will serve as a trainer.The IDS Tornado will become the major weapon in the overland and maritime roles replacing the Buccaneer and also the Vulcan. Some reconnaissance squadrons will also replace their aircraft with Tornados.

The AM-C 111 was "inspiration" for HAL's own 24-seat commuter aircraft design, the HAC-33

Mike Savage, the BAC 1-11 and *Vayu*

In the fitness of things, it is appropriate to reproduce extracts of an article by Mike Savage, great friend of *Vayu* and its team, who wrote 'On Board the One-Eleven 475' as they flight demonstrated in India during 1976, just after the Farnborough show. This appeared in *Vayu's* Issue of October 1976.

Indian Airlines, the subcontinent's domestic carrier, has been actively considering the replacement of its turbo-prop fleet of Fokker F-27s and Hawker Siddeley 748s. The reason behind this decision comes about largely because of capacity considerations (the twin Dart-powered aircraft carry only around 44 passengers), but also because of a need to update the shorthaul equipment. It was with this requirement in mind that the operator requested BAC to demonstrate a One-Eleven 475 on a carefully chosen network of regional airfields, providing natural hazards to operation such as high attitudes or obstacles close to the runway. These airfields were linked by stops at major airports such as Bombay, Madras and Calcutta as well as Delhi. Previously, a 500 Series One-Eleven in the colours of *Dan-Air* had visited Delhi to provide first-hand knowledge of the One-Eleven at an early stage.

So it was that at 11.36 on 30 June One-Eleven 475 '1002' of the Sultan of Oman's Air Force arrived at Delhi's Palam Airport, borrowed by BAC for five days for arduous evaluation flying. BAC's Capt David Glasser brought 1002 from Muscat to India – the non-stop flight from Muscat to Delhi took under four hours.

40 Years young: Mike Savage with Vayu's Managing Editor in London, July 2016

Next day at 07.42 '1002' took off from Palam Airport to begin a tour which was to take in most of India, Assam, Kashmir and even into Nepal. On board were a team of Indian Airlines senior executives, project pilots, engineering staff and aircraft evaluation experts. In total, between 50-60 passengers came around the circuit and David Price, A BAC photographer, was on hand to keep a record of the trip.

With Captain Madhu Dayal, Indian Airlines Deputy Operations Manager, in the left hand seat, we flew to Bhavnagar on the first day, 510 n.m. away. The temperature was 30°C and Bhavnagar's 5,400 ft. runway is host only to turbo-props on scheduled services. It has a marginal LCN (bearing strength) of 22. Practically the whole of this small agricultural community turned out to greet the One-Eleven and after a short stop, Captain Dayal took the One-Eleven onto Bombay, the western corner of the so called golden triangle linking Bombay, Calcutta and Delhi.

And that was when Mike Savage first met with *Vayu* … and the rest is history !

Jordanian F-16s for Pakistan?

Pakistan is considering buying older generation F-16 fighters from Jordan, after the plan to procure eight of their latest variant from the United States fell through. Some of Pakistan's inventory of early model F-16s are due to be phased out in the next few years. "We are now going for a third-party transfer of F-16s and have an offer from Jordan," Defence Secretary Alam Khattak told a joint sitting of the Senate defence and foreign affairs committees. An air force spokesman declined to say how many F-16s Pakistan has but the number of the aircraft in service is believed to be about 70. Jordan had offered to sell Pakistan 16 used F-16s of the Block-30 variant, an older version than the Block-52s that Pakistan would have obtained from the United States. Pakistan has bought Jordanian F-16s before, procuring 13 of them in 2014 while the current batch on offer were manufactured between 1988 and 1990, being upgraded in 2001-02.

F-35 programme transition

The F-35 is entering a critical transition period from a development phase with low-rate production to operational status and full-rate output. The USMC has activated its first F-35B squadron in Yuma, Arizona, with limited capabilities while the USAF plans to achieve IOC with the first F-35A squadron from August, although the critical back-end system for managing spare parts and logistics will not be ready until October. Meanwhile, Senator McCaine has opposed a Pentagon bid to have the Joint Programme Office (JPO) manage the 'Block 4 upgrade' as an extension of the existing programme. He prefers the $8 billion modernisation package be managed as a separate programme, with competitive acquisition and a fixed-price development contract.

The National Defence Authorisation Act for fiscal year 2017, would eliminate the JPO after the Lockheed Martin fighter transitions to full-rate production, two years later. Responsibilities would be divided by variant, with the US Air Force taking procurement and modernisation of the F-35A and the US Navy gaining the same over the F-35C and the F-35B, for the US Marine Corps. Meanwhile, rollout of the first Japan Air Self-Defence Force (JASDF) F-35A has been set for 29 September at Fort Worth, the aircraft (AX)-1 being the first of four being assembled at Fort Worth. Remainder of the 42 will be assembled in Japan at Mitsubishi Heavy Industries' final assembly and check-out facility in Komaki, Nagoya.

All Swedish AF Gripens at MS20 standard

The Swedish AF has operationalised the new MS20-standard software for its Saab Gripen C/D fleet of six squadrons, representing a significant increase in operational capability. The process of introducing the standard began with MS20 adding MBDA's Meteor beyond-visual-range air-to-air missile and Boeing's GBU-39 small diameter bomb to the weapons suite. Changes include enhanced Link 16 functionality, a new data link to enhance capability in close air support missions, expanded functionality for the pilot's helmet-mounted sight, an infrared reconnaissance pod and an automatic ground collision avoidance system. Ulf Nilsson, head of Saab Aeronautics, describes the enhancement as a "revolutionary update". According to Swedish air force chief Maj Gen Mats Helgesson, the Meteor's addition is of particular significance. "From our perspective, that's a game-changer. Sweden's is the first air force operating the Meteor, with the long-range system also to be introduced on France's Dassault Rafales and Eurofighter Typhoons flown by Germany, Italy, Spain and the UK. Up to 16 GBU-39 bombs can also be carried following the MS20 update, using four-round launchers for the 110kg (250lb) strike weapon.

Thai F-16 MLU

The Royal Thai Air Force (RTAF) has tested the capabilities of its new F-16 MLU during *Cope Tiger 2016*, the annual air combat exercise, using the Joint Helmet Mounted Cueing System (JHMCS). The RTAF has completed an upgrade of 18 Block 15 F-16A/B to Block 52 standard, which included installation of the Northrop Grumman APG-68(V)9 radar and the Link 16 data link module. For the first time, Link 16 was successfully used to conduct a tri-lateral link-up involving RTAF F-16MLUs, Republic of Singapore Air Force F-15SGs and US Air Force F-15C Eagles.

Russian Air Force expands

An order has been placed for "an additional 30" Sukhoi Su-30SM multi-role fighters for the Russian Air Force, the contract between the Russian Defence Ministry and Irkut Corporation, being part of the State Defence Order for 2016-2018. Reports give the number as 36, of which eight will join the Russian Navy. Deliveries are scheduled to be completed by the end of 2018. Russia's Defence

Ministry has also signed a contract with Irkut Corporation for the supply of 30 Yak-130s to the Russian Air Force, deliveries to begin early next year and be completed by the end of 2018. Another upgraded Tupolev Tu-95MS has been delivered back to the Russian Air Force, even as Ilyushin has begun flight testing of the first modernised Il-76MD-M. The mid-life upgrade includes a new avionics suite, radio communications, lighting and self-protection equipment. The upgrade is being developed for the Russian Air Force, which plans to modernise 40 of its Il-76M/MDs, extending service life by a further ten years. Similar work is planned for an as yet undetermined number of Il-78M tankers.

More Su-25s for Iraq

The Iraqi Air Force has received a further three Su-25 attack aircraft from Russia, being two single-seaters and one two-seat Su-25UB, having received an initial two Su-25SMs from Russia in June 2014. With three more received thereafter, these were initially deployed at Imam Ali (Tallil) Air Base. A further five are also believed to have been delivered subsequently. On 1 July 2014, three Iranian Islamic Revolutionary Guards Corps Air Force (IRGCAF) Su-25s were also delivered to Baghdad/Al-Rashid Air Base, while a further four from the IRGCAF arrived at Al-Rashid the next day. Iran then delivered one more Su-25 on 14 July 2015. The type is flown by the IqAF's 109th Attack Squadron, based at Al-Rashid.

In this context, it is relevant that Russia has withdrawn all its Su-25s from Syria. Russian Defence Ministry spokesman Major General Igor Konashenkov stated that some 30 aircraft, including bomber and attack types, had returned to Russia but "just enough" had been left to continue the fight against terrorist groups.

Denmark selects F-35A

Danish Prime Minister Lars Løkke Rasmussen has confirmed the F-35A Lightning II's selection to replace the Royal Danish Air Force (RDAF) F-16 fighters, with 27 F-35As being ordered and deliveries scheduled to begin in 2021 and completed by 2027. Selection of the type had been made during a meeting of top government officials in May, following conclusion in the previous month by defence ministry experts that the F-35A "was the most suitable option for the RDAF, instead of the Boeing F/A-18E/F Super Hornet and Eurofighter Typhoon." Denmark originally intended to buy 48, but later reduced this number.

Meanwhile, the first two Lightning IIs in service with the Royal Netherlands AF *(see on previous page)* are operated by 323 Test & Evaluation Squadron (TES), based at Edwards AFB, California, and until 2019 will be involved in the multinational F-35 Operational Test and Evaluation (OT&E) programme.

Israel's first JSF *Adir*

Lockheed Martin marked rollout of the first Israeli Air Force F-35A Lightning II, which is a major production milestone for the future of Israel's national defence. "Israel is proud to be the first country in the area to receive and operate it," said Avigdor Liberman, Israel's Minister of Defence. "The F-35 is the best aircraft in the world and the choice of all our military leadership at its highest level. It is clear and obvious to us and to the entire region that the new F-35, the Adir, will create real deterrence and enhance our capabilities for a long time."

Israel's F-35, named *Adir*, 'Mighty One' in Hebrew, will be a significant addition to maintaining Israel's qualitative military edge in the Middle East region, with its advanced capability against emerging threats, including advanced missiles and heavily-defended airspace. "The F-35 combines advanced low observable stealth technology with fighter speed and agility, fully fused sensor information, network-enabled operations and advanced sustainment support."

Rolls-Royce, P&W support for RAF's F-35B

Rolls-Royce and Pratt & Whitney will provide comprehensive technical support at Royal Air Force Marham to support F135 engines and the LiftSystems on the UK's F-35B Lightning II aircraft. The two engine companies will institute a Performance-Based Logistics (PBL) approach to sustainment for the propulsion systems. A PBL contracting structure incentivises contractors to focus on outcomes such as propulsion system availability, leading to greater efficiencies, mutual cost reductions, and operator benefits.

The agreement defines how the companies will collaborate and grow their sustainment capabilities. Pratt & Whitney, lead propulsion integrator for the F-35 programme, will focus primarily on system-level performance of its F135 engines. Rolls-Royce will lead on support for the LiftSystem technology the company developed and produced, while also undertaking some delegated support work on the main F135 engine.

Weapons package for Iraqi F-16C/Ds

The US Government has approved sale of a major package of weapons for the Iraqi Air Force's Lockheed Martin F-16C/D Block 52 fleet, which will ultimately number 36 aircraft. Valued at around $1.95 billion, the Foreign Military Sale includes air-to-ground munitions in the form of 150 AGM-65D/G/H/K Maverick missiles, 14,120 500lb bombs for precision or unguided use, 2,400 2,000lb bombs, 8,000 Paveway II laser-guided bomb (LGB) tail kits to build GBU-12 guided bombs, 250 Paveway II tail kits for GBU-10 guided bombs, and 150 Paveway III tail kits for GBU-24 guided bombs. In terms of defence equipment, the deal includes 20 Joint Helmet-Mounted Cueing Systems (JHMCS) and 24 AIM-9M Sidewinder missiles.

Iranian Air Force C-130s upgraded

The Islamic Republic of Iran Air Force (IRIAF), which is among the larger Lockheed Martin C-130 Hercules operators in Asia, has some 35-aircraft in three transport squadrons at two major bases.

Their missions include tactical transport; troop and equipment airdrop; aeromedical resupply; medical evaluation; disaster relief; and signals and electronic intelligence across Iran, Iraq and Syria in the war against terrorism.

In February 2008, IRIAF HQ contracted with the Iranian Ministry of Defence for the Iranian Aircraft Industries Company (IACI) to upgrade the C-130s under project *Sattari*, which included installation of HF and U/VHF radios manufactured under licence by Iranian Electronic Industries, a Russian-made moving map and multifunction display (MFD) and a radar altimeter. The IRIAF plan to keep their C-130s in service till 2030.

More Russian Su-34 delivered

Another four Sukhoi Su-34 fighter-bombers have joined the Russian Air Force at Komsomolsk-on-Amur/Khurba. The aircraft are part of the 2016 State Defence order, and first of the type to join a Russian Air Force and Air Defence unit in the Eastern Military Division. These aircraft will begin replacing Su-24/24M2 *Fencer-Ds* in the former 277th Fighter Bomber Regiment at Khurba.

Future Luftwaffe Plans

The German Government's latest *Air Capability Strategy Paper* reveals details of plans for the Luftwaffe. Among the platforms included in the paper is the Future Combat Air System (FCAS), intended to be a manned or unmanned long-term successor to the Panavia Tornado. The Eurofighter Typhoon will be employed for air defence needs and Luftwaffe intends to retain the Tranche 1 fleet as long as is economically viable. Tranche 3A deliveries will be completed in 2018, and work will also begin to expand the Typhoon's air-to-ground armoury, including the GBU-48 Enhanced Paveway II guided bomb in the short term, a new short-range air-to-surface missile (ASM) by 2020, a medium-range ASM from 2020, and new maritime anti-surface warfare and suppression of enemy air defences capabilities from 2025. There are also plans to introduce the Captor-E active electronically scanned array radar and an improved targeting pod.

Nigerian Air Force Alpha Jets

The Dassault-Dornier Alpha Jet has once more adorned Nigerian AF markings, with some four having been received from various sources. The NAF took delivery of two other Alpha Jets in March and May 2015, both of which were acquired from Air USA Inc, The NAF bought four of the type from the company last year, and although these aircraft have been sold to Nigeria in a demilitarised configuration, the NAF has modified these two to carry weapons to support Operation *Lafiya Dole* counter-insurgency missions against Boko Haram in the northeast of the country.

Indonesia confirms Su-35 order

The Indonesian Air Force is to acquire 10 Sukhoi Su-35 multi-role fighters. Indonesian Minister of Defence Ryamizard Ryacudu said that a contract would be signed including training of pilots in Russia. Indonesia already operates 11 two-seat Su-30MK/MK2 and five single-seat Su-275SK fighters. Meanwhile, Russia's deputy minister of defence, Maj Gen Igor Lotenkov has announced that Belarus is to become the latest customer for the Sulhoi Su-30SM multi-role fighter, to replace existing MiG-29s.

Bahrain evaluating new fighters

Bahrain is reportedly considering an upgrade for its fleet of Lockheed Martin F-16 fighters, which numbers 16 F-16Cs and four two-seat F-16Ds. As well as modernising these existing fighters, the kingdom is apparently examining a purchase of upto 18 new-generation F-16Vs. The Indian Government is reportedly offering the Tejas LCA to Bahrain, even as the JF-17 is on the shortlist.

JF-17 Block II

The JF-17 Block II will incorporate an in-flight refueling probe. While the first probe closely resembled the design used on the Pakistan Air Force's upgraded Mirage III and was mounted immediately behind the canopy, the new version is a much more refined design, resembling the Chengdu J-10A's probe, and mounted under the left cockpit side. The modified JF-17 also features a spotlight for night refueling operations.

Australian P-8A Poseidon maiden flight

Australia's first P-8A Poseidon aircraft has made its maiden flight, having flown a short distance from Renton Airfield to Boeing Field in Washington State USA, where the P-8A's sophisticated mission systems will be installed as part of project AIR 7000. The $5.4 billion P-8A programme is to provide Australia's future manned maritime patrol and response aircraft capability, replacing in part the AP-3C Orion aircraft.

Head of Aerospace Division, Air Vice Marshal Catherine Roberts stated "Aircraft production includes around $25 million of high-tech production work undertaken by local subsidiary, Boeing Aerostructures Australia. The primary roles of the P-8A include the detection and response to naval surface and submarine threats, surveillance and reconnaissance, and assisting in search and rescue operations."

With a saving of US$260m compared to the initial budget, the P-8A Poseidon aircraft were acquired through a cooperative programme with the United States Navy and contracted to Boeing Defence Space and Security. A Royal Australian Air Force crew will fly the aircraft to Australia in late 2016 following post-production checks and acceptance.

Pakistan Army orders Medevac Cessnas

Cessna Aircraft will provide six new air ambulance aircraft to the Pakistan Army Aviation Corps, these being acquired through a Foreign Military Sales contract. The deal, worth $14m, covers two Cessna 208B Grand Caravan EXs and four Cessna T-206H Stationairs to be modified for aero-medical evacuation. A 24-month sustainment package covers spares, tooling and support equipment for each aircraft. Pilot and maintainence training will also be provided, with completion due by 30 December 2016. The Pakistan Army had recently taken delivery of its first two Grand Caravan EXs.

12 CH-47Fs for Netherlands

Twelve CH-47F Chinooks have been ordered for the Royal Netherlands Air Force (RNLAF), with Boeing awarded the $308m Foreign Military Sales contract on 14 April by the US Army. On 9 March 2015, it was revealed that US State Department approval had been granted for 17 new CH-47s. However on 7 September, Dutch Minister of Defence Jeanine Hennis-Plasschaert said that owing to budget restrictions, just 14 would be purchased and the final contract confirms there have been further reductions. The current RNLAF Chinook fleet comprises 11 CH-47Ds and six CH-47F(NL)s.

Safran engines for South Korean LCH and LAH Helicopters

Korean Aerospace Industries (KAI) has selected Safran Helicopter Engines as engine supplier for its Light Civil Helicopter (LCH), to be powered with the existing Arriel 2C2 engine. On the Light Armed Helicopter (LAH), Safran has been selected by Defence Acquisition Programme Administration (DAPA), KAI and Hanwha Techwin, which will feature a new engine designated Arriel 2L2.

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Derived from the Arriel 2N, the Arriel 2L2 features a combination of new and proven technologies. Compared to the previous Arriel 2 generation, it has a new axial compressor, new high-pressure compressor diffuser, new high-pressure turbine material and new-generation dual-channel Fadec. Arriel 2L2 will be the most powerful Arriel variant and will provide "better safety, reliability, power and performance during demanding missions."

USS *Carl Vinson* receives MV-22 Osprey

In preparation for the planned replacement of the C-2 Greyhound, USS *Carl Vinson* (CVN 70) received a V-22 Osprey from Marine Operational Test and Evaluation Squadron (VMX) 1 for landings and takeoffs on 12 June. The V-22 is being tested and evaluated as it is scheduled to become the singular logistics platform on an aircraft carrier for future carrier on-board delivery operations.

UK signs for 50 Boeing AH-64E Apaches

The United Kingdom has finalised purchase of 50 Boeing AH-64E Apache helicopters that will be equipped with GE's T700-701D engines. In August 2015, the United States Defence Security Cooperation Agency (DSCA) announced the UK's request to remanufacture the British Army Air Corps' fleet of Apache Mk 1 aircraft, upgrading to the advanced AH-64E Guardian model.

Algeria receives Mi-28NEs

According to reports, Russian Helicopters has delivered four Mi-28NE attack helicopters to Algeria, the first two transported onboard an An-124. A further two arrived soon afterwards on a separate flight. These helicopters have dual controls, similar to the recently developed Mi-28UB variant. Algeria has ordered a total of 42 of this type.

Rotary-Wing Training in UK

Ascent Flight training has been awarded a contract by the UK Ministry of Defence on rotary-wing training elements as part of the UK Military Flying Training System (UKMFTS) programme. The contract will involve delivery of 29 H135s and three H145s by Airbus Helicopters for training of 286 students annually by 161

instructors: 102 military and 59 from Ascent, which will continue until 2033. The helicopters will be powered by Safran's Arrius 2B2Plus and Arriel 2E turbines for the fleet of Airbus Helicopters H135 and H145.

All core training elements within the UKMFTS programme are now under contract, with aircrew from all three Services to conduct their basic and advanced rotary-wing training at RAF Shawbury and Army Air Corps Middle Wallop in Hampshire. Mountain and maritime rotary-wing training will be at RAF Valley, Anglesey.

Airbus Helicopters will deliver an integrated support solution over a period of 18 months, ready to begin training in April 2018, and include developing all of the necessary support infrastructure and also training initial crews and maintenance personnel. The H135s and H145s will operate 28,000 flying hours per year as required to meet the training requirement, and Britain will also be the first country to receive the newly updated H135 Helionix.

RAF receives eighth A400M Atlas C1

Another A400M Atlas C1 has been delivered to the RAF, landing at RAF Brize Norton, Oxfordshire, on 11 May. This now brings total RAF A400M deliveries to eight, of a total of 22 aircraft being acquired for employment by the RAF.

Uzbekistan receives H225s and AS350s

Airbus Helicopters has delivered a batch of H225 Super Puma and AS350 Ecureuil helicopters to the Uzbekistan Air Force, under an €180m euro contract with what was then Eurocopter in 2013 for eight AS332s (now designated H225s) and eight AS350s, all for its Air Force and in military configuration.

Raytheon JSOW C-1 for US Navy

Raytheon and the US Navy have completed all operational tests for the Joint Standoff Weapon C-1, making this newest variant of the guided glide weapon ready for US Navy fleet release and declaration of Initial Operational Capability. JSOW C-1 includes a Link-16 datalink and maritime moving target capability to provide fleet forces with robust, flexible capability against high-value, stationary land targets. This now includes moving maritime targets at launch ranges of up to 70 nautical miles from both fourth-generation fighters and the fifth-generation Joint Strike Fighter. JSOW C-1 is the US Navy's first air-launched, net-enabled weapon, with internal integration on the F-35 already underway.

Elbit upgraded C-130s for Israel

Flight tests have been carried out on the C-130H Hercules transport aircraft upgraded by Elbit Systems for the Israeli Air Force. During the flight tests, the aircraft's systems performance was tested in various modes of operation and in a variety of flight altitudes and conditions, both by day and night. The test demonstrated 'out of the window' flight, in which live video was displayed on the head-up display (HUD), presenting flight and navigation data overlaying the real world by using two and three dimensional symbols, enhanced visual landing applications and head tracking capabilities.

AW139s for Pakistan

The government of Pakistan has ordered "an undisclosed number" of search and rescue (SAR)-configured AgustaWestland AW139s for operation by the Pakistan Air Force. The order is part of a fleet renewal programme spread over several batches and includes a logistic support and training package. Deliveries are due in 2017 and the helicopters will undertake SAR missions throughout the country. Eleven AW139s already operate in Pakistan, with the Army Aviation Corps' 6th Army Aviation Squadron at Dhamial for transport and humanitarian relief; two are also configured for the VIP/VVIP role. The other six are with civilian operators.

Korean Army AH-64Es delivered

South Korea has received the first four of a batch of 36 Boeing AH-64E Apache Guardians for the Republic of Korea Army (ROKA). Boeing was awarded this Foreign Military Sales contract after selection for the requirement on 17 April 2013 by South Korea's Defence Acquisition Programme Administration, the type having competed with the Bell AH-1Z Viper and TAI T-129.

Y-20 joins PLAAF

China has inducted its largest indigenously developed and built strategic transport aircraft, the Xian Y-20, in a breakthrough that enhances the strategic airlift capability of the world's largest standing army, to transport material and troops over long distances. With a maximum takeoff weight of 200 tonnes, the Y-20 is comparable to the Boeing C-17 Globemaster III. It has a range of 4,850 miles while carrying 40 tons of cargo, or 2,800 miles when fully laden. The Y-20 had made its maiden flight in January 2013 and underwent extensive trials, including operations in the high mountain terrain of Tibet.

Currently the Y-20 uses four Russian-made Soloviev D-30 turbofan engines, although the PLAAF plans to replace these engines with Chinese-made Shenyang WS-20 turbofans by 2020.

US Navy's Triton UAS demonstration

The US Navy recently demonstrated two key capabilities for the Triton Unmanned Air System (UAS) programme that will enhance future fleet operations. During a flight test on 2 June 2016, an MQ-4C Triton and P-8A Poseidon successfully exchanged full motion video for the first time inflight via a Common Data Link (CDL), marking another interoperability step for the programme. The test demonstrated Triton's ability to track a target with its electro-optical/infrared camera so as to build situational awareness for a distant P-8 aircrew.

The MQ-4C Triton's ability to perform persistent intelligence, surveillance and reconnaissance within a range of 2,000 nautical miles will allow the P-8A aircraft to focus on their core missions. Triton is designed to fly missions of up to 24 hours at altitudes over 10 miles high, allowing the system to monitor two million square miles of ocean and littoral areas at a time. The Navy will continue testing Triton at Patuxent River to prepare for its first planned deployment in 2018.

USN P-8A Poseidons join 4th Fleet

US Naval P-8A Poseidons have been deployed at Comalapa, El Salvador on 23 June, as part of the 4th Fleet, these aircraft from Patrol Squadron (VP) 26 ('Tridents'). The P-8A is a derivative of a modified Boeing 737-800ERX airliner, bringing together a reliable airframe and high-bypass turbo fan jet engine with a fully connected, state-of-the-art open architecture mission system. "It combines superior performance and reliability with an advanced mission system that ensures maximum interoperability in support of operational efforts."

First *Mistral*-class helicopter carrier for Egyptian Navy

DCNS has delivered the first of two helicopter carriers acquired by the Arab Republic of Egypt in October 2015, the LHD (Landing Helicopter Dock) *Gamal Abdel Nasser*. By 2020, DCNS will have supplied at least seven combat vessels to Egypt, "thus

contributing to the modernisation of the Arab Republic of Egypt's defence system." On 10 October 2015, DCNS had signed a contract with the Arab Republic of Egypt for the supply of two *Mistral*-class LHDs. In addition, DCNS is committed to supporting the Egyptian Navy over the longer term, under the multiannual maintenance contracts for the Egyptian vessels as well as through technologies transfer allowing the Alexandria Shipyards to build three of the four *Gowind* corvettes ordered in 2014. Other projects are currently under consideration to accelerate enhanced operational capability of the Egyptian Navy.

TAP is launch airline for A330neo

TAP Portugal will be the launch operator for the new Airbus A330neo, the initial A330-900neo due to fly early in 2017, with the Portugese airline scheduled to receive the first of 14 examples at the end of next year. The A330neo family variants have secured 186 orders from 11 customers and TAP will also be the first airline to introduce Airbus' *Airspace* cabin concept. *Airspace* is based on the cabin developed for the A350 XWB and features larger over head space bins, 18in-wide (457mm) seats, LED mood lighting, new lavatories, more personal space and improved in-flight entertainment and connectivity (IFE&C). TAP's A319s, A320s, A321s and A330ceos will be retrofitted with new seats and IFE&C to complement the Airspace-configured A330-900neos.

Russia's four regional airliner options

According to reports from Moscow, Russian president Vladimir Putin has received proposal-options for four regional airliners of 50-60 seats, including three turboprops and a jet. These include a Russian-assembled Chinese Xian Aircraft MA700; revival of the Ilyushin Il-114, powered by Klimov TV7-117 engines and built by Ulyanovsk-based airframer Aviastar; while the 50-seat Antonov An-140 is an alternative, jointly developed with Ukraine. Russia had also considered assembly of Bombardier Q400 turboprops, but this plan lapsed over differences concerning Ukraine. Another option could involve resurrection of the Tupolev Tu-324 concept, a 50-seat twinjet with aft-mounted engines, which programme did not progress beyond the initial research phase because the Irkut MC-21 became "a development priority."

CSeries on route trials

The Bombardier CSeries CS100 flight test aircraft has completed a series of route-proving flights in Europe as service entry of the new narrowbody twin-jet nears. The aircraft flew on 30 city pairs across the continent from Zurich, the home base of CS100 launch

operator Swiss, with stops including Milan, Paris and Warsaw. The flight used Swiss' normal routings and operational procedures to verify data about CS100's airfield performance, landings, turnarounds and on-ground operations in normal day operations. The programme followed route-proving conducted late last year across North America. Swiss has taken delivery of its first CS100 in June. Separately, the second flight test example of the CS100's larger stablemate, the CS300, conducted its first flight from Mirabel. The CS300 is due to receive certification in the middle of this year.

'Steady Progress' for MRJ

The MRJ90 regional jet is "making steady progress" in its flight testing, according to manufacturer Mitsubishi Aircraft (MITAC). Recent flight testing milestones include an initial flight over the Sea of Japan, a first sortie with an escort aircraft and checks of the ram-air turbine operations for emergency electric power generation. Meanwhile, the full MRJ Fatigue Strength Test Aircraft has been transferred to the test station for assessments. MITAC said separate tests underway using a static strength test specimen "are moving forward according to schedule." The MRJ prototype first flew on November 2015, since when flight testing progress has been "sedate".

Boeing plans to "stretch" 777s

Boeing is proposing to stretch its largest 777 model to create a twin-engined mega airliner "to compete with Airbus Group's A380." Having approached several carriers about the 777-10X, including Dubai-based Emirates, the world's largest operator of both Boeing's 777 and Airbus's double-decker aircraft, the proposed model would carry about 450 travelers, sharpening its rivalry with the A380. Boeing would need to stretch the fuselage of its 777-9 to incorporate about four extra rows of seats.

While Emirates has "considered" the new 777 variant, there is no confirmation of selection as yet. The carrier had ordered 289 jets from Boeing's 777 family, including 150 of the upgraded versions, the 777X. Boeing unsuccessfully pitched Emirates on its 747-8 two years ago as a potential A380 replacement. While the Gulf carrier, which has taken 80 A380s and last month ordered two more, taking the backlog "to 64, has been pressing Airbus to upgrade the model for fuel efficiency."

Debut of China's ARJ21

On 28 June, China's first indigenously developed and built passenger jet entered commercial service, whose debut is already a decade late and underscores problems in Beijing's bid to become a global aviation player. Aviation officials, executives and journalists were among the first passengers aboard the ARJ21 regional jet on the Chengdu Airlines flight, which departed the central city of Chengdu after some fanfare featuring ribbon-cutting and a posse of panda mascots. The ARJ21, or Advanced Regional Jet for the 21st century, can carry between 78 and 90 passengers with a range of 2,200 kilometers, according to its state-owned manufacturer, Commercial Aircraft Corp. of China.

Russia's New Jetliner

On 8 June 2016, Irkut Corporation (a member of UAC) conducted the official rollout of the first MC-21 aircraft designated for flight tests. As Oleg Demchenko, the President of Irkut Corporation emphasised, "Construction of the first aircraft is a significant milestone of the MC-21 programme. We are looking forward to greet our partners, current and prospective customers, representatives of federal and regional authorities at Irkutsk Aviation Plant." Beginning in 2020, Irkut Corporation plans to produce 20 MC-21 aircraft per year, increasing the rate of production to 70 aircraft in 2023, with first delivery planned for the fourth quarter of 2018.

China Eastern Airlines orders 20 A350 XWBs

China Eastern Airlines has signed a purchase agreement with Airbus for 20 A350-900s, making the airline the latest customer for the aircraft, which features the latest aerodynamic design, carbon fibre fuselage and wings, plus new Rolls-Royce Trent XWB engines. "For passengers the extra-wide cabin offers more personal space in all classes, including 18-inch wide seats as standard in economy class."

Philippine Airlines orders A350 XWBs

Philippine Airlines (PAL) has finalised a purchase agreement with Airbus covering an order for six A350-900s, plus six options. The A350 XWB will become the flagship of PAL's future long haul fleet and will be configured with a premium three class layout. The airline will operate the aircraft on non-stop flights to the US, as well as on services to new destinations in Europe.

Garuda Indonesia orders 14 A330neo

Garuda Indonesia has confirmed an order with Airbus for the purchase of 14 A330-900neo widebody airliners, to support the company's growth and business expansion in the future. Garuda Indonesia plans to use the A330neo to develop its medium and long haul network, with the aircraft offering cutting edge technology along with more efficient operations. The order replaces and extends an existing order for seven A330-300 aircraft, the first A330neo to be delivered from 2019 onwards.

Saab to build A321 ACF Over Wing Doors

Saab will design, develop and manufacture the Over Wing Door component for the Airbus A321 Cabin Flex programme. This new door design will be installed on all Airbus A321s equipped with Airbus Cabin Flex which will improve aircraft evacuation during emergency situations. Saab will be responsible for the development and manufacture of the Over Wing Door and for development and procurement of manufacturing tools.

Part of the development will be completed by the Saab/Mahindra collaboration at the Saab India Tech Centre (SITC) in Hyderabad, while part of the assembly will be carried out at Saab/Aequs JV Aerostructures Assemblies India in Belgaum.

CFM LEAP-1B Engine for Vietjet

Vietnam's Vietjet has ordered CFM International's LEAP-1B engine to power 100 Boeing 737 MAX aircraft in a contract valued at $3 billion US, including spare engines. Based in Ho Chi Minh City, Vietjet has been a CFM customer since it commenced operations in late 2011 and currently operates a fleet of 35 aircraft.

Sikorsky's S-92 milestone

The global fleet of Sikorsky S-92 helicopters (more than 275) recently surpassed one million flight hours, in an impressively short time of less than 12 years. With more than one million fleet flight hours of service, and an accident rate less than 1/10th the US civil multi-turbine engine helicopter rate, Sikorsky believes "the S-92 helicopter sets the industry standard for safety and reliability." The S-92 was certified to FAA/EASA harmonised Part 29 requirements, as amended through Amendment 47, leading the way by being the first aircraft certified to this rigorous standard and by meeting or exceeding oil and gas industry requirements. The availability rate of the S-92 fleet averages more than 95% each month.

Pilatus delivers 1,400th PC-12

Pilatus Aircraft has delivered its 1,400th PC-12, achieving a significant flight time milestone for the NG fleet. An additional milestone was achieved by the fleet of 630 PC-12 NG (Next Generation) models, the latest version of the PC-12, which surpassed the 1 million flight hour mark since its introduction in 2008. The worldwide fleet of all PC-12 aircraft has accumulated more than 5.6 million total flight hours since certification.

The 2016 model PC-12 NG incorporates a number of significant enhancements, including a 5-blade composite propeller, aerodynamic drag reduction features, a 285 knot cruise speed, avionics feature upgrades, and new interior and exterior design choices.

Trent XWB engines for Virgin Atlantic A350-1000s

Rolls-Royce has won a $900m order from Virgin Atlantic for Trent XWB engines and TotalCare long term services for 12 Airbus A350-1000 aircraft. The order covers engines and TotalCare for twelve aircraft, including four leased aircraft, with engines already ordered, to be operated by Virgin Atlantic. The A350-1000 aircraft, which will fly for the first time later this year, features a higher thrust version of the engine, the Trent XWB-97, which began flight tests last November.

Second H130 for Royal Bhutan

Royal Bhutan Helicopter Services Limited received its second H130 on 21 June, following the first delivery in October 2015. Similar to the first H130, the second helicopter comes equipped with additional optional equipment such as an integrated tracking system, cargo sling, bambi bucket firefighting and an onboard medical stretcher enabling to perform medical evacuations, as per Bhutan's environmental policy of the Royal Government. Within the same period, the first H130 has ferried more than 400 passengers including VIP and tourism flights.

A350-1000 to fly by year-end

The first Airbus A350-1000, being structurally completed in Toulouse, is to make its maiden flight by year-end as it moves through the final-assembly process. According to Airbus, the first of three test aircraft (MSN059) "is progressing well in the final assembly line" and "first flight is on track to happen by end of the year." The stretched, 360-seat derivative of the A350-900 is equipped with more-powerful Rolls-Royce Trent XWB-97 engines. The first -1000 is due for delivery in mid-2017.

Boeing projects mid-range airliner

Boeing is considering development of a de novo-design jetliner aimed at 'middle-of-market', which is assessed to be between 4,000 and 5,000 in number. According to Mike Delaney, general manager of airplane development, after discussions with "some 36 airlines, there is confidence that Boeing will be working on a replacement for 757." Further, Mike Sinnett, who heads product development for the company's commercial division, has indicated that such a new airliner would seat between 200 and 270 people with a range of about 5,000 nautical miles. Boeing's rival, Airbus has gained sales by pitching its A320neo "as the 757's heir", with the European narrow-body airliner having notched 1,125 orders against 222 for Boeing's rival 737 Max 9. "But the largest Airbus model can't be stretched to reach the sweet spot of the market that Boeing envisions", Delaney stated.

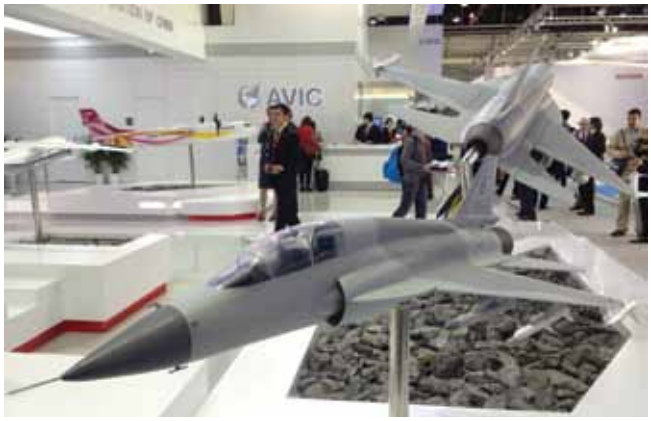
Gripen E delivery targets

Saab is targeting on-schedule delivery of its new Gripen E fighter to the Swedish and Brazilian air forces in 2019 even as it steps up export campaigns involving both the advanced model and its earlier C/D model. The first of three Swedish test aircraft (39-8) should make its maiden flight by end of the year, and will initially verify the general systems, airframe and aerodynamics of the evolved design. With 40% more internal fuel capacity, it has greater range, payload and endurance, and features an active electronically scanned array (AESA) radar, other updated avionics and new electronic warfare equipment. Saab Chief Executive Håkan Bushke has said that the cost of developing the Gripen E and producing its three test aircraft "will be less than $2 billion."

Sweden has ordered 60 Gripen Es for delivery from 2019, while Brazil will field an initial batch of 28 single-seat Es and eight twin-seat Fs, including units to be completed at a new facility at Embraer's Gavião Peixoto site. Its order includes a single-seat test asset, currently in production.

Two-seat JF-17B

After joint development, Pakistan and China have begun production of the first prototype of a two-seat version of the JF-17 Thunder. Sub-assembly work on the JF-17B was formally launched during an induction ceremony at the Chengdu Aerospace Corporation (CA) facility in China on 27 April. Speaking at the ceremony, Air Marshal M Iqbal said the two-seat version will be of great value for the PAF, not only improving training, but also operational capability. He added that the induction of dual-seat JF-17B aircraft would also "improve prospects in the future export market". The prototype JF-17B is expected to make its maiden flight by the end of this year, and go into PAF service by April 2017.



Lockheed Martin's T-X Plans

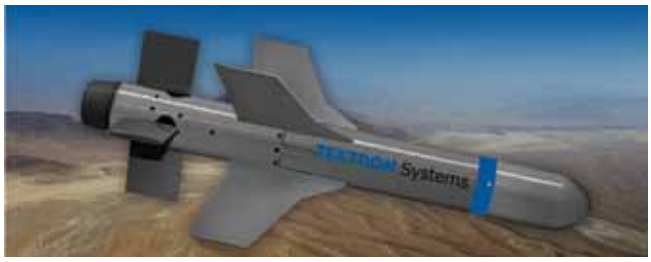
Lockheed Martin has revealed, plans to offer the T-50A supersonic jet trainer in response to the US Air Force's competition to replace the T-38C advanced jet trainer. Although the contractor's 'Skunk Works' advanced development division has been working on a de-novo design, it decided to offer a modified version of the Korean Aerospace Industries (KAI) Golden Eagle as it would be "far less expensive than a totally new aircraft." Lockheed Martin's plans include establishing a new final assembly and check-out facility in Greenville, South Carolina. Two examples are being modified into production-representative T-50A prototypes in Korea which will support Lockheed Martin's US testing and sales efforts. Lockheed Martin's T-50A ground-based training system (GBTS) will offer an advanced ground-based training platform and the company believes that the T-50A's cockpit, using flight controls and displays similar to those of the F-35, would also ease transition from introduction to fighter fundamentals (IFF) stage to the Formal Training Unit (FTU). Meanwhile, Boeing with Saab and Northrop Grumman plan to offer de-novo designs for the T-X requirment.

Glass Cockpit upgrade for Hawk Mk51

Esterline CMC Electronics (CMC) has been selected by Patria, Finland, to perform a glass cockpit avionics upgrade of a further seven BAE Systems Hawk trainers for the Finnish Air Force. The existing fleet of Hawk Mk51 and Mk66 aircraft provides basic and advanced training at Tikkakoski Air Base for pilots destined for F/A-18C and F/A-18D equipped front-line squadrons. This new contract covers the adaptation of Esterline CMC's Cockpit 4000 integrated avionics suite for an additional seven Hawk Mk51 trainer aircraft currently held in reserve in their original analogue state. The upgrade aims to further increase the quality of flight training, by improving the Hawk jet trainers' training efficiency and extending the training sylabbus currently carried out on Hawk aircraft.

Textron's Fury glide weapon tested

Textron Systems Weapon & Sensor Systems and Thales have tested the Fury lightweight precision guided glide weapon from



the Shadow Tactical Unmanned Aircraft System (TUAS) against static vehicle targets. During such testing, the Fury was released from 8,000 feet altitude, conducted a Global Positioning System (GPS) guided fly-out maneuvere and transitioned to the Semi-Active Laser (SAL) guided terminal engagement, directly striking a static vehicle target. The Fury weapon uses a common interface for rapid integration on multiple manned and unmanned aircraft systems. The weapon's tri-mode fusing, impact, height of burst and delay, further enables a single Fury to address a broad target set, ranging from static and moving light armoured vehicles to small boats and personnel.

First Taganrog-assembled Be-200ES rolled out

Beriev's factory in Taganrog marked roll out of the first Be-200ES amphibian to be assembled at the facility, the aircraft due for delivery to Emercom, the Russian Ministry of Emergencies. Manufacture of the Be-200 was previously undertaken at the Irkutsk Aviation Plant and Beriev later established high-tech production facilities and upgraded production lines, workshops and composite structure production facilities at Taganrog. Director General and General Designer of Beriev Aircraft PJSC, Yuri Grudinin, noted that the new version, which is now being built at Taganrog has incorporated a number of significant upgrades.

nEUROn publicly displayed

At an air meet at Istres on 4 June 2016, organised by the French Air Force, the nEUROn unmanned combat air vehicle demonstrator was publicly shown for the first time, this stealth aircraft being controlled from the ground. The three aircraft flew past in formation at an altitude of 150 metres at 350 km/h. This flying display, in a limited airspace, "represents a real achievement, both technically and in terms of flying skills". The event was conceptualised by teams from Dassault Aviation, along with the French defence procurement agency DGA and the French Air Force and showcased the reliability and safety demonstrated by the nEUROn since testing began in 2012.

Earlier, in March 2014, the nEUROn had become the world's first unmanned combat air vehicle to fly in formation with other aircraft (a Rafale and a Falcon 7X). Furthermore, outside the United States, the nEUROn team is the first in the world to have designed, built and flown a stealthy unmanned combat air vehicle demonstrator and the first to have submitted this to a comprehensive test programme.

Thales Scorpion HMSD onboard Korean LAH

Thales' Scorpion helmet-mounted sight and display (HMSD) has been selected for Engineering, Manufacturing and Development (EMD) for South Korea's Light Armed Helicopter (LAH). Thales will provide 400 HMSD Scorpion which will be onboard LAH at the beginning of the 2020s, the LAH programme covering 200 helicopters.

The Scorpion head tracking system is HObIT (Hybrid Optical based Inertial Tracking) and "provides highly accurate, reliable, and non-intrusive cockpit integration. Scorpion is fully compatible with all standard Night Vision Google."

Small Diameter Bomb II flight testing

Raytheon and the US Air Force have begun flight testing of the Small Diameter Bomb II in two additional modes: Coordinate Attack and Laser Illuminated Attack. SDB II features a highly advanced tri-mode seeker, enabling the weapon to use imaging infrared, millimeter wave and laser guidance to find targets on the battlefield. In the Coordinate Attack mode, SDB II employs its on-board GPS system to attack high-value, fixed targets from close positions and from standoff ranges of greater than 40 miles. In the laser mode, SDB II utilises its semi-active laser to track and eliminate laser-illuminated targets. Developmental testing will continue with more normal attack, coordinated attack and laser illuminated attack flight testing.

South China Sea Exercises

Just days after an arbitration court in The Hague invalidated China's vast territorial claims in the South China Sea, China cut off access to part of the disputed area for military drills, starting on 19 July, controlled by its command on Hainan island. China has been conducting combat air patrols in the region, which are slated to become a "regular practice in the future."

The PLAAF has sent H-6K bombers, fighters, scouts and tankers to patrol islands and reefs that include Huangyan Dao, according to a spokesman for the PLA Air Force. "To effectively fulfil its mission, the air force will continue to conduct combat patrols on a regular basis in the South China Sea," he said.

China has repeatedly blamed the United States for stirring up trouble in the South China Sea, a strategic waterway through which more than $US 5 trillion of trade moves annually. In recent years, China has been dredging sand and building on islands in order to improve the basis of its claim over them. China, Brunei, Malaysia, the Philippines, Taiwan and Vietnam in turn have rival claims in the South China Sea.

Russia to deploy missiles at Kaliningrad by 2019

Russia will reportedly deploy advanced nuclear-capable missiles in its European exclave of Kaliningrad by 2019, a direct reaction to the proposed US-backed missile shield in the region. This would escalate what is already the worst standoff between Russia and the West since the Cold War and put a swathe of territory in Poland, Lithuania, Latvia and Estonia in the cross-hairs. Russia has often threatened to put nuclear-capable Iskander-M missiles in Kaliningrad, a slice of Russia wedged between Poland and Lithuania, as a riposte to the shield, part of which went operational in Romania in June 2016.

Red Arrows at the Queen's 90th Birthday

In a far more benign display of air power, the RAF's Red Arrows formation aerobatic team are seen flying over Buckingham Palace for Queen Elizabeth II's 90th birthday. Also in flypast were the special Battle of Britain flight, including Spitfires and Hurricanes which preceded contemporary Typhoons.

Exercise *Iniohos*

Rising Star in Greece

Israeli Air Force F-16s at Andravida Air Base during Iniohos 2016

The Hellenic Air Force (HAF) Air Tactics Centre is called *Kentro Aeroporikis Taktikis* (KEAT). It has its home at Andravida Air Base in the north western part of the Peloponesian Peninsula and between 4 and 14 April KEAT hosted its annual *Iniohos* exercise. This was established in the late 80's as small scale HAF-exclusive air exercise, but a transformation was announced in late 2013, based on experiences abroad during exercises like *Red Flag* in the USA and the Tactical Leadership Programme (TLP) held in Europe. *Iniohos* was converted to a medium scale INVITEX ("Invite Exercise") so that interested foreign nations could participate. Also, instead of operating from their home bases, all participating assets would relocate and operate from Andravida Air Base, in the so-called single base concept. KEAT commander and exercise director, Colonel Dimitrios Panagiotopoulos, explained: "By implementing these changes the HAF could provide better training in the way of (de-) briefing together, planning together and building social contacts. It improves the learning curve significantly and therefore provides a higher pay-off for all participants involved."

Like last year, the 2016 edition of *Iniohos* was conducted simultaneously with the Hellenic Navy exercise *Astrapi* but Hellenic Army assets like AH-64D Apaches also participated. Last year marked the first edition with foreign participation when twelve Israeli Air Force F-16I *Sufa* (*Storm*) and United States Air Force Europe (USAFE) Joint Terminal Air Controllers, or JTACs, joined the exercise. Pleased with last year's results the Israeli AF returned this year, this time with aircraft from all three F-16C/D squadrons based at Ramat David Air Base. USAFE also participated, with JTACs and twelve F-15E Strike Eagles of the 492nd Fighter Squadron based at RAF Lakenheath in the UK. Colonel Robert Novotny, 48th Fighter Wing Commander and an F-15E pilot with over 2,000 hours, explained why his unit joined the exercise: "First of all Greece is a strategic and important partner for stability in the Mediterranean area. USAFE units rotate yearly to Greece for training in order to be interoperable should that need arise. For our unit specifically it is a great work up for our summer deployment to the USA where we will participate in *Combat Hammer* and *Red Flag*. Also it gives me the opportunity to qualify some pilots to mission commander status using this demanding exercise with multiple composite

Two Mirage 2000s of 331 Mira before take off during 'Iniohos'

Rarest of participants at Iniohos was a Gulfstream G550 'Nahshon-Eitam' AEW&C of 122 Squadron based at Nevatim Air Base

A 492nd Fighter Squadron F-15E thunders down the runway at Andravida

A rarely seen EMB 145H Erieye AEW&C of 380 Mira was a participant during Iniohos 2016

Israeli F-16C from 110 Squadron 'Knights of the North' based at Ramat David takes off for an Iniohos 2016 mission

USAFE F-15Es heading out to depart as a HAF F-16 awaits its next mission

air operations (COMAO) flown during the course of the exercise."

Iniohos offers a wide variety of missions in air warfare employment, with participating units commanded by the 'Chief of Tactical Air Force' but operational control is with the KEAT commander. Col Panagiotopoulos commented on the operational possibilities: "With participation of the Army and Navy, mixed force operations are executed with large formations of aircraft attacking but also defending targets on land e.g. command and control targets, while at sea naval forces attack and in the air for instance defending a High Value Airborne Asset (HVAA) like an E-3 AWACS. Simultaneously, Defensive Counter Air (DCA) operations are executed in order to protect our own forces and to secure our strategic structures."

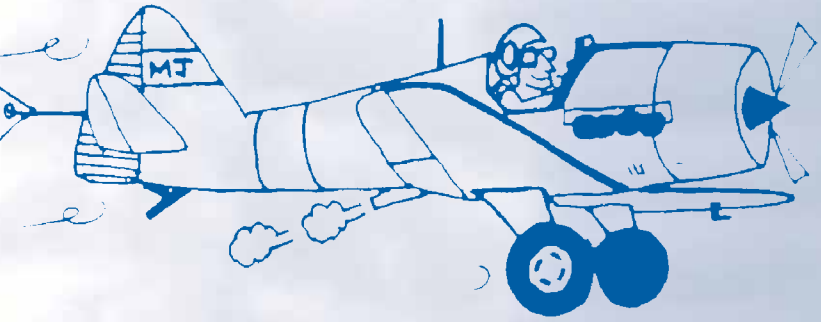
As Colonel Novotny elaborated: "Yesterday I flew a mission as Force Protection Leader. First I did some Offensive Counter Air (OCA) work followed by some low level Close Air Support (CAS) during which an American JTAC helped me to my first target followed by a Greek JTAC for my second target. In my opinion this shows the versatility of what exercise *Iniohos* can offer."

Iniohos is increasingly an exercise that is gaining interest with other air arms. For example, a high ranking French Air Force officer was present as an observer during *Iniohos* 2016, possibly resulting in future participation. The HAF is keen on promoting the exercise, with HAF Chief Lieutenant General Christos Vaitsis saying, "*Iniohos* is the most important exercise for the HAF. It offers high-level training in a demanding and realistic environment. With the introduction of foreign participants it will bring the quality of HAF personnel to an even higher level. Colonel Panagiotopoulos agreed, noting that multiple countries in and outside of Europe have shown interest in *Iniohos* and that Egypt is a possible participant in next year's edition. "After last year's visit of our [HAF] Mirage 2000s of 331 Mira to Tanta Air Base in Egypt during exercise *Houras* 2015, this could happen sooner or later," he felt.

The star of *Iniohos* seems to be rising and could be a welcome change for air forces that are looking for a demanding exercise where day and night flights are incorporated with few operational restrictions, often contrary to flying at home.

Text and photos: Stephan van Geem, Patrick Smitshoek and Remco Stalenhoef

Ancient Aviator Anecdotes



Of Hawks and Harriers

Hawk T.1A of the RAF

A recent news item (*see Vayu III/2016*), pertaining to phase-out of the Harrier aircraft from our Navy, took me back 36 years to a chain of unexpected events that led to my first and only flight in that type. In 1980 I was attending a course at the Royal College of Defence Studies (RCDS), London. Among my British colleagues was an engineer from British Aerospace (BAe, now BAE Systems). Over a friendly get-to-know-each-other beer, he asked me how I felt about the Indian government's interest in the possible acquisition of the BAe Hawk and Harrier aircraft ? Since they were both proven platforms in service with the RAF and RN, there was no doubting their utility. As to their suitability in meeting our needs, I felt flying experience on type would be of help.

Coincidentally, a few weeks later, I received a call from our Air Advisor in London informing me that four familiarisation sorties on the Hawk had been offered to the Indian Air Force. Air HQ had advised that since I was already in London, medically fit and in current flying status, I could carry out the sorties and for which period I would be treated as being on flying duties. Furthermore, since I had earlier inducted the Polish Iskra trainer into the Air Force, I was also required to submit a report regarding suitability of the Hawk for advanced and applied stages of flying training. I readily accepted the offer provided RCDS would permit me to do so during the Easter break; this was immediately agreed to.

On 17 April 1980, accompanied by the Deputy Air Advisor, I reported to RAF Valley and was delighted to meet up again with an erstwhile RAF student at our own Staff College Wellington in 1974, where I had then been a DS (Air); he was to fly me. After a thorough briefing and kitting I had a most enjoyable and educative sortie as he left most of the actual flying to me. Two days later we relocated to RAF Brawdy where I was able to carry out some live firing from another Hawk including both rockets and guns. I duly submitted my report to the Air Advisor.

Among the close personal friends I had made at RCDS was an RAF colleague who, like me, had a Hunter background. He had raised and commanded the RAF's first Harrier squadron in 1969. I shared with him my experience of the Hawk, which he had yet to fly! During the college land tour of Europe in July, both of us were in the same group at a NATO air base in Germany where his old squadron was now based. He was offered a sortie in their Harrier T.4 but very kindly asked the RCDS Commandant (an RAF AVM) if the sortie could possibly be offered to the Air Commodore from India? The Commandant had no objection and I certainly had none! Time did not permit me to take permission from India, so I immediately got briefed, kitted and quite enjoyed my very first experience of V/STOL flight in Harrier T.4 913 captained by a Flt Lt Harris. That evening my forex reserves were severely depleted, as I had to stand drinks all round at the bar! On return to London I explained the situation to our Air Advisor. He was a close friend but felt

RAF Harrier T.4 trainer, similar to the one flown by the author (photo: Mike Freer)

that since the flight was a *fait accompli*, I might consider rendering a report on what American aviators term as a 'dollar ride!'

Whether my report(s) actually reached any senior decision maker, I still do not know but was happy to learn that in 1983 the Sea Harrier was inducted into our Navy and that today the Hawk is in service with both the Indian Air Force as well as the Navy.

A Call and Recall

In all professions the acquisition of skills and knowledge depend largely upon the quality of instruction imparted. It is however, only when these attributes are actually applied in practice, that experience is gained and self-learning commences. Perhaps, the training and education in our Air Force is as good an example as any other. As pilot trainees in 1951-52 we underwent 18 months of learning, both in the air and on the ground. Most of our instructors had served in the RAF/RIAF and transferred their learning and experience to us as future pilots, officers and gentlemen of the IAF.

Learning to fly was a challenge and great fun but ground subjects were less so. The syllabus of the latter included a few lectures on 'Customs of the Services,' a manual by a Gp Capt Stradling of the RAF, for which it was a definitive guide. Our fledgling Air Force was still in the process of indigenising our own customs, hence, in the interim, continued to follow those laid down in this book. We were taught about the significance of 'Dining-in Nights' and had one every week in our own Flight Cadets Mess. We also learned the social requirement of calling upon the Commanding Officer (CO) of the unit one was posted to. It laid down procedure for making an appointment, dress, duration and other protocols, which included discreetly leaving two visiting cards!

After graduation and completion of fighter conversion (all on piston-engined aircraft), three of us coursemates were posted as Pilot Officers to the very first squadron of the IAF equipped with jet aircraft (Vampires). Jet trainers were still three years away so we were launched solo after detailed ground briefing. We learned to cope and built up our individual expertise because every sortie was a self-learning experience. On the ground our Adjutant (a future Air Marshal and Chairman of HAL) made us print visiting cards (no ranks for pilot officers, only 'Mr'!) and arranged a date/time for us to make a call on our Squadron Commander.

Our CO (Sqn Ldr GKJ) was a thorough gentleman, soft spoken and avuncular in nature. We were still immobile and yet to acquire bicycles, hence walked to his residence anxiously clutching our newly printed visiting cards! At exactly 7 pm we pressed the doorbell and were welcomed by our CO who promptly relieved us of the visiting cards, served us drinks and snacks personally and got to know us socially outside the work environment. At exactly 7.30 pm (after exchanging meaningful glances with each other) we rose, thanked him for his hospitality and prepared to exit. He politely escorted us out, thanked us for coming and then, with a twinkle in his eye, informed us that the 'call' was over and ushered us back into the house where his wife had a delicious home cooked dinner awaiting us. We had a most enjoyable, informal and relaxed evening at the end of which our CO dropped us back in his car.

The next morning, in response to his query, we assured the Adjutant that we had got up and exited after the prescribed 30 minutes. He seemed satisfied and our CO had a quiet, conspiratorial smile for three young officers who had learned a great deal from his thoughtful and kind gesture, an example of experiential learning we would adapt and put into practice ourselves in future years.

AVM (retd) Cecil V Parker

25 Years Back

From Vayu Aerospace Review Issue IV/1991

India's Civil Aviation Policy

The priorities facing the country and the State are qualitatively different in 1991 to those pertaining in 1953. In the intervening forty years, whilst the State has developed increasing inertia, the private entrepreneur has become more dynamic; the State has become less confident and the businessman more self-assured. In this changed environment, motivation and the market forces have attracted competence and ability away from the orbit of the State's employ. These and many more changes that have occurred during the past forty years requires an essential re-appraisal of the basic policy premise on which nationalisation was based. Concisely, nationalisation was an act which took a pragmatic view of the then extant ground realities and market demands. The policy changes now required, should take an equally pragmatic view of the current and the future emerging demands in the market place.

The private entrepreneur, whether of the in-country or NRI variety, is still not in a position to launch or sustain modern scheduled airline operations of any sophistication on his own. Therefore, he needs to be nurtured in the larger national interest.

"India is prepared for War"

New CAS Air Chief Marshal NC Suri has said that the country was ready to meet the challenge "should a war be thrust on us." During a visit to air force stations and forward air bases in the Kashmir valley on 14 August, his first after taking over as Chief of Air Staff, he told fighter pilots and other officers that they should be fully prepared to meet any contingency. On queries from journalists about the reported war hysteria being built up in Pakistan, Air Marshal Suri said that at present the Indian Air Force is "more than a match" to any adversary in the region. He inspected the newly-inducted mobile Osa AK-M Russian-built air defence missile system, which has anti-nuclear, anti-biological warfare and amphibious capabilities. It also has an in-built ultra-sensitive radar.

Thrust on Defence Exports

The Defence Minister Sharad Pawar has projected the country's defence products infrastructure in a new commercial role, saying that he would like to give a major thrust to defence exports, making it a foreign exchange earner for India. Mr Pawar said the decision to go ahead with the Light Combat Aircraft (LCA) project had been a deliberate one. "Today or tomorrow we have set up our own units…substantial parts of the LCA are being developed in India, but some are still imported, and efforts are on to build even these here," he said.

Cut in Defence Outlay Likely

The Government is considering a reduction in the defence budget to make good the loss it sustained in partially surrendering to the demand of ruling party as well as Opposition members of Parliament on reducing fertilizer prices. Exercises are said to be on in the Defence Ministry to figure out areas that could sustain possible cuts in budget allocations. The budget estimates for defence for 1990-91 are Rs 16,350 crores, only Rs 600 crores more than previous year's estimate. Adjusting for inflation, this is seen approximately as a standstill figure. In the interim budget presented in March, the defence allocation had been pitched at Rs 16850 crores. Thus, the Finance Minister, Dr Manmohan Singh's projected estimate is already Rs 500 crores less than this figure.

Prithvi deployment in 1992

India is undertaking a massive programme involving both public and private sectors for the production of Prithvi and Trishul missiles for deployment in 1992, according to the Defence Research and Development Laboratory director, Dr APJ Abdul Kalam. The success of the Indian Guided Missile Programme, so far, has demonstrated the country's independence from foreign technology. Describing it as the 'Trajectory of Independence from Foreign Technology,' he said that production and deployment were the ultimate objective. For the Prithvi and Trishul there were 34 institutions and R&D organisations involved in design and technology development, with transfer to 22 public sector undertakings, 10 ordnance factories and nine private sector industries for production.

Air India records over Rs 60 crores profit

Air India has recorded a net profit of over Rs 60 crores in the financial year 1990-91. According to unaudited figures, the Operating Revenue crossed the Rs 1600 crore mark, an increase of Rs 250 crores over the Operating Revenue of Rs 1368 crores achieved in 1989-90. The yield, measured in terms of Revenue Tonne per Kilometre (RTK) increased to Rs 10.75 as against Rs 8.75 achieved in the preceding year – a record 25 percent rise. Significantly, Air India has been able to maintain its trend of high profitability for the third successive year after absorbing the additional impact on account of these factors without curtailing any of the amenities offered to the first and business class passengers and also without laying off employees either in India or abroad – the two factors resorted to by some of the international airlines for pruning costs.

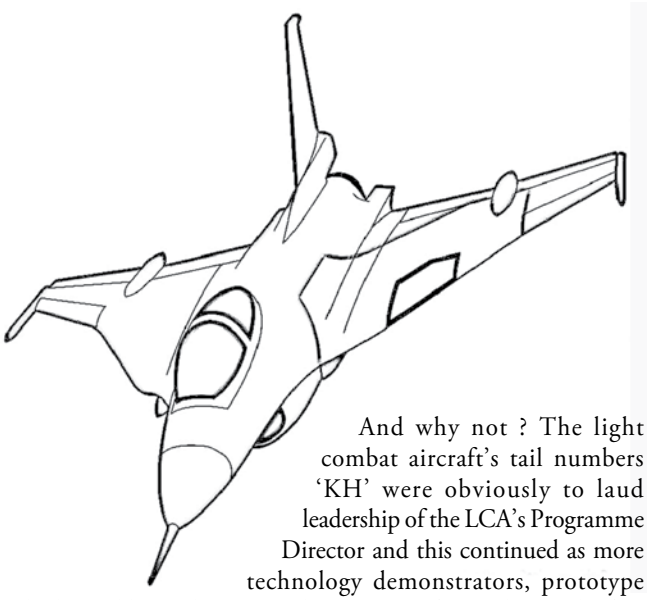
ISRO for Foreign tie-ups

Chairman of the Indian Space Research Organisation (ISRO), Prof UR Rao has called for collaboration with international electronics giants to ensure the country makes swift progress in the field. ISRO had so far effected 178 space-based technology transfers to industries and another 100 were on the anvil. Of these, 54 were in telecommunications, navigation and broadcasting, 46 in chemicals and special materials, 28 in optical instruments and 24 in electronics and computers. In Karnataka, 52 units had received the know-how, a majority of them in the private sector. Adequate infrastructural facilities would be provided and special incentives sanctioned.

Tale Spin

What's in a (tail) number ?

HAL's new turboprop trainer made its debut flight at Bangalore in June, to much applause but also curiosity concerning its tail number 'TSR 001'. Aviation wags immediately connected that to the aborted British Aircraft Corporation programme TSR-2 of the late 1950s, but were later informed that actually these were initials of the present Chairman HAL who has been greatly supportive of this new design & development programme.



And why not ? The light combat aircraft's tail numbers 'KH' were obviously to laud leadership of the LCA's Programme Director and this continued as more technology demonstrators, prototype vehicles and limited series production aircraft were built. The first series production aircraft however carry the alphabets 'LA' which has thrown the wags into some confusion : could these be the first letters of the then Air Chief's surname ?

In contrast, development of HAL's intermediate jet trainer has been an issue and its tail number remains a mysterious 'S'.

Killing them softly

India's soft power clearly has dimensions and potential that most people are unaware of. Whether the government itself is aware of it is moot, given that it is the British forces fighting ISIS in Libya that used Bollywood music to throw them off kilter. Music as a psychological weapon in interrogation is not a new idea, and the fact that one person's music is another person's cacophony is amply borne out by history and anecdotal evidence. However, apart from instances from Hollywood movies—and perhaps the Biblical episode of Jericho's walls falling because of Joshua's massed trumpets—the use of music in actual warfare in modern times is not common. Bombarding battle-hardened fundamentalists with Bollywood music—the brainwave of a Pakistan-born British intelligence officer—is indeed devilishly clever.

From The Economic Times

The 'Good Country' Index

According to a report recently published, taking various UN and World Bank indices into account, Sweden has been ranked as 'the best country in the world' when it comes to serving the interests of its people and contributing to the common good of humanity while India figured low at 70th position on a list of 163 nations. (Libya was ranked as the 'least good' country in the world).

It is fortuitous that the Indian Government is favourably looking at the proposal from Sweden's aerospace industry to 'Make in India', such a comprehensive programme surely having multiple spin-offs for the general good of India as well.

History Alive

INS *Vikrant*, the Indian Navy's iconic first aircraft carrier, served the nation well through peace and war till it was de-commissioned. All attempts to retain it as a floating maritime museum came to naught and finally the ship was sent to the scrapyard in 2014. Naval historians were distraught as this majestic icon was to be ripped apart.

But there is 'life after death' as the Pune firm Bajaj Auto, have stepped in and purchased a large amount of the *Vikrant's* scrap metal. Voila ! The company is using this for manufacturing the fuel tank of their V-Bike, now embellished with a "V" shape in the form of an aircraft carrier.

Ride Navy !

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