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Cover : LCA (Navy) Mk.1 making deck landing on INS Vikramaditya, 11 January 2020 (photo by Debadatta Maharana)

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COMMENTARY

Starting on the right note

The new Indian Army chief, General MM Naravane has laid out his vision of the role of the forces as well as outlined the challenges the army faces. In itself, this may have passed off as a routine briefing. But the intervention was particular significant because of the broad political context in which it was made, the evolving security landscape, and the change in the national security architecture underway with the appointment of the Chief of Defence Staff.

What stood out in General Naravane's comments was his firm and unequivocal commitment to the Constitution (of India). To be sure, every army chief has worked within the constitutional structure. But at a time when politics is deeply polarised, and there has been concern over the somewhat political remarks made by Naravane's predecessor, General Bipin Rawat, the chief's comment are a reminder of the broad principles which govern the Indian Army. His emphasis on the fact that the army fights to preserve values of liberty, equality, fraternity and justice for citizens shows a deep belief in the original vision of the drafters of the Constitution and provides a deeper justification of the army's mandate. His emphasis on respecting fundamental rights carries meaning, for security compulsions have often been posited against civil liberties – in effect, the chief was suggesting that the motive for the army to provide security was to enable citizens to exercise these rights. His comments also reflects a commitment to the framework of civil-military relations, where the elected government is the final authority.

The other thread of the Chief's remark was on the challenging security situation India faces, on both the China and Pakistan fronts. But these are not necessarily independent fronts, given the deep nexus between Islamabad and Beijing. By highlighting the Siachen (Glacier) as a potential space where this collusion could happen, he was alerting the country to the sensitivity of one of world's toughest battle terrain. His emphasis on rebalancing, which meant enhanced preparations across the northern border with China, was based on the recognition that India's strategic challenge - notwithstanding the emphasis on Pakistan in everyday discourse - perhaps lies elsewhere. The COAS also reiterated the Indian Army's commitment to the broader integration of services, which is the CDS's remit. Put it all together, General Naravane came across as a clear, articulate thinker, committed to the Constitution, and also focused on the need to modernise India's forces and train them with an eye on the evolving security challenges.

From *The Hindustan Times*

Why not Indian ?

Russia, traditional supplier of mobile ground systems to the Indian army, is reportedly upset at the army's procurement process for self-propelled air defence gun missile systems, which began in 2013, dragged itself painstakingly through assorted tests and assessments, and is on the verge of inking a deal with South Korean defence manufacturer Hanwha Defense. Defence procurement is a minefield of lobbying and it is easy for the non-specialist to get lost in the technical capabilities or defects attributed to various models touted by various manufacturers. But what can be made out is that the Indian defence procurement system needs urgent overhaul for Indian defence manufacturers to turn from bit suppliers to sophisticated systems designers and integrators.

According to various reports, one of the two systems from Russia on offer meets the requirements of modern battle conditions, with its 3D radar that is capable of recognising and targeting small drones. However, this machine failed the 30-degree gradient test. So, the army is settling for the South Korean model, which has a 2D radar and will not be able to target small objects like drones. The Russians want to be given another chance to prove that their equipment can meet the specified norms. However, the real question is not whether the Russians should get the order or the Koreans. Why should India be obliged to buy the entire kit from any particular vendor? India is a large enough arms importer and endowed with sufficient manufacturing expertise to procure the components, from whichever company in whichever country, and integrate them as per its requirements. It has the money, the nous and the diplomatic clout to pull this off. What it seems to lack is the procurement process and the political will to do this.

The CAG report on Rafale warplanes had brought out that the shoddy manner in which Air Staff Quality Requirements were specified was one reason for delays in procurement. Specify the functional requirements, not technologies, bid for components, not finished systems, and integrate them at Indian shops.

From *The Economic Times*

The Navy's Challenge

The task of defending India's maritime borders falls on the Indian Navy. Its Chief has highlighted the challenges that the force faces in the Indian Ocean and spoke of the need for greater budget allocation. Increasing Chinese presence in the Indian Ocean, as well as aggressive Chinese attempts to find fresh-water ports in littoral states, have been a cause of concern. The 'String of Pearls' in the Indian Ocean region has long been a Chinese geopolitical strategic maxim. It has achieved a considerable measure of success in establishing facilities that serve its naval and commercial interests. Chinese presence in Hambantota, Sri Lanka, and its developing the Gwadar Port in Pakistan as a military base have rightly been causes of concern for Indian strategists.

The Navy, therefore, has a significant challenge. It needs more ships, and as its Chief has rightly suggested that even before that happens, upgrade of the existing vessels can go a long way. Admiral Karambir Singh's practical approach would work admirably since electronic and other enhancements would be force multipliers even as new ships are planned and built. His plea for the restoration of the budget to what it was - 18 per cent of the total defence budget, rather than the present 14 per cent - is also prudent. He is certainly not asking for the moon.

The Navy's role in defending the territorial waters of the country does not get the attention it deserves. It has played a significant role in wars, including the 1971 Indo-Pak conflict where it got a real chance to show its mettle by blockading Karachi on the one hand, and successfully blockading East Pakistan with the aircraft carrier INS *Vikrant* on the other. Subsequently, it has been integral to various military operations. It has also carried out humanitarian missions and anti-piracy patrols. The Navy has every reason to be proud of its service to the nation. The need for an adequate budget is a fundamental one and should be fulfilled without much delay.

From *The Tribune*

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BOEING

COMMENTARY

Let's get real !

There is a worrying disconnect between the Indian Navy's budget and its spending plans. On the one hand, the navy has told a parliamentary panel on defence that it plans to build 24 new submarines, including six nuclear attack submarines (SSNs). On the other hand, the CNS Admiral Karambir Singh, has publicly lamented that, with the navy's share of the overall defence budget having shrunk from 18 per cent in 2012-13 to just 13 per cent this year, it will have to make do with just 175 warships in 2027 instead of the 200 envisioned in the *Maritime Capability Perspective Plan*.

So dire is the navy's fund shortfall that the defence ministry has been putting off sanctioning a second indigenous aircraft carrier (IAC-2), which will cost more than Rs 275,000 crore, including the cost of its aircraft. There is similar vacillation in green-lighting Project 75-I, which involves spending Rs 245,000 crore on six conventional submarines with air-independent propulsion. There is the continuing liability of some Rs 290,000 crore on six nuclear-propelled submarines armed with nuclear-tipped missiles (SSBNs), of which only two have been completed. While such programmes are paid for over at least a decade, they would still require the navy to pay over Rs 220,000 crore from its capital budget each year. The SSN project would load another Rs 10,000 crore of annual 'liability on the navy. Sanctioning these four projects will require the navy to more than double its capital budget, which stands at Rs 225,656 crore for this financial year. The current budget is already stretched in paying for the 50 warships currently under construction, and for another 41 ships and 61 helicopters that are sanctioned in principle and likely to be contracted. Major capability upgrades such as IAC-2, Project 75-I, SSBNs and SSNs require significantly higher allocations, but those are not realistically forthcoming, given the sharp economic slowdown and the fact that defence modernisation already accounts for more than one-third of the central government's overall capital budget.

Until the economic climate changes, the military, including the navy, will need to heed then Prime Minister Manmohan Singh's November 2013 exhortation to "cut our coat according to our cloth." The navy is already taking in its belt with the decision to overhaul its aging submarines -12 of its 15 conventional submarines have already served more than a quarter century - so as to keep them in service for another decade. Steps must also be taken to fill capability gaps in other warships, such as the shortfall in torpedoes and active sonar systems. And the clear and evident shortfall of specialist ships like minesweepers and anti-submarine vessels must be filled on priority. The navy chief has already underlined the need to focus on maximising warship capabilities instead of bemoaning the shortage of numbers. In modem warfare, better maritime domain awareness through satellites and aerial reconnaissance aircraft translates into battle-winning operational advantages. Similarly, improved networking and command systems, along with more lethal on-board weaponry, allow fewer war-ships to deliver greater battlefield effects.

Finally, India must tighten its international maritime partnerships in fulfilling the role of being the primary "net security provider" in the Indian Ocean. Currently, the navy is overstretched with continuous anti-piracy patrols, mission-based deployments from West Asia to the Strait of Malacca and joint exercises with every major world navy. Given the magnitude of these tasks, India should harness its diplomatic goodwill to share the burden.

From *Business Standard*

Upgrade of US-India ties ?

The second round of the '2 plus 2' dialogue between India and the United States involving the foreign and defence ministers of the two countries — which took place in Washington late December 2019 — appears to give us a new paradigm, that in India-US relations two plus two is on a trajectory to becoming six. The press statement of the ministry of external affairs, issued a day after the 2 plus 2 engagement is transcript of the statements of US secretary of state Mike Pompeo, US defence secretary Mark Esper, minister for external affairs S Jaishankar and defence minister Rajnath Singh to the media in Washington. It was followed by a brief question and answer session. It is possibly the clearest enunciation that the Narendra Modi government is seeking the kind of engagement with the US that India had developed with the USSR in the bipolar, Cold War era.

The Indo-Soviet Treaty of Peace and Friendship, a bilateral security agreement struck in the wake of US nuclear capable warship, *Enterprise* moving into the Bay of Bengal to threaten India as Pakistan was losing its eastern wing to form Bangladesh, had been signed in one shot. India's shiny new deal with the United States is analogous, not identical, and has been a stage-by-stage affair in which rapid, decisive strides were taken by the present government, with the compass fixed firmly in one direction.

The recent dialogue in Washington seems the first firm intimation that New Delhi will not be held back from embracing Washington in a wide-arc politico-military alliance in a manner that may suggest a NATO-member like newfound status (in the Indo-Pacific theatre) for India. Plainly, India will be the inferior ally, America the superior, commanding global strategic partner.

India being drawn into the US embrace has a context — the American tilt to the Pacific and its search for allies there, as its interest in NATO declines with its new-found non-reliance on energy sources in West Asia, and its concomitant emerging interest in containing China rises. In addition to Japan and Australia, India is the partner in this venture in the 'Indo-Pacific', the new US coinage for the Pacific area. The Modi government has evidently found the opportunity irresistible, given India's frictions with China besides other considerations.

In the recent dialogue at Washington, Mr Pompeo suggests that the two countries had practical discussions on not just bilateral matters but on Iran, China, Afghanistan and Pakistan, besides Nepal and Sri Lanka. It was the over-arching, across-the-board nature of the political conversation that was striking. His Indian counterpart did not get into specifics, perhaps bearing in mind sensitivities back home.

However, the points made by India's defence minister were revealing. It appears now the Indians will be posting a liaison officer with the American naval base in Bahrain, from where the Americans militarily oversee the Gulf area. There is to be a link between our naval headquarters and the US Indo-Pacific Command. Senior-level participation in deliberations with the Indian military has been solicited from the US CentCom and AfriCom (Central Command and Africa Command). We are on the cusp of a new era.

From *The Asian Age*

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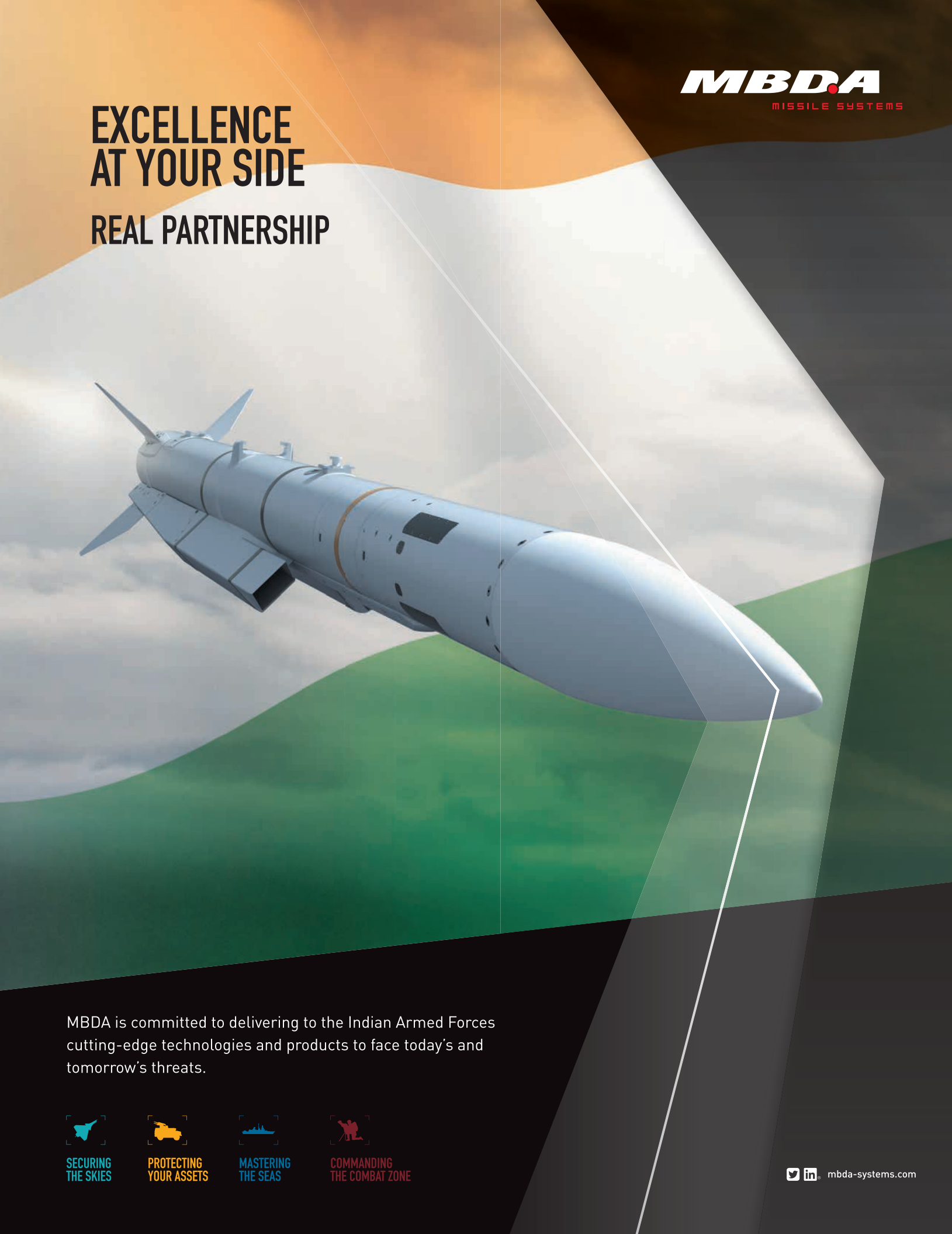

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Admiral Arun Prakash on

Deciphering the CDS

At the risk of sounding hyperbolic, it must be said that the creation of a Department of Military Affairs (DMA), with a Chief of Defence Staff (CDS) at its head, on New Year's Day 2020 was the most significant development in the national security domain since independence. First mooted in 2001 by a Group of Ministers (GoM) in the aftermath of the Kargil conflict, successive administrations – NDA and UPA – have baulked at creation of the CDS. The Modi government, having jettisoned the doctrine of 'strategic restraint' in its first term, deserves full credit for initiating a long-overdue process of national security reform, whose first 'green shoots' are the CDS and DMA.

It is, therefore, a pity that the dissonance of nation-wide protests against the Citizenship Amendment Act (CAA) and impending National Register of Citizens (NRC) has served to diffuse focus on this issue of vital security importance and evoked personality-related controversies.

In the latter context, it needs to be borne in mind that selection of important office-holders – civil and military – remains the prerogative of the government in power. While numerous factors, including seniority, may have their place, it is 'acceptability' of the individual, to the government, that adds weight to his 'merit' and tilts the balance. Since all selections are, ultimately, made on merit, no individual needs to feel beholden to the government. The military ethos requires that he retains his professional independence and upholds his oath of allegiance to the Constitution.

From the ongoing public debate and discussion it is obvious that not everyone is clear about the need, importance and implications of many of the measures enumerated in the Government of India (GoI) press release regarding the CDS. As a participant in the GoM process of 1999 and a member of the 2011 Naresh Chandra Committee on security, this writer will attempt to highlight some areas which are likely to have a far-reaching impact on India's security scenario.

Firstly since 1947 the three Service HQ (SHQ)s designated as 'Attached Offices' of the DoD, have remained 'outliers' vis-à-vis the MoD and GoI. The Service Chiefs, lacking recognition/standing in the GoI Business Rules, are heard politely by the Raksha Mantri (RM), who then turns to the Defence Secretary for advice. Communication between SHQ and DoD takes place largely through the medium of files.

With creation of the DMA, headed by CDS, the military will, for the first time, be admitted into the central edifice of the GoI and become a participant in policy-making. Designation of the CDS as Principal Military Adviser (PMA) to RM will enable unhindered access to MoD, accelerating the process of decision-making and accord of approvals. To ensure adequate availability of expertise, civilians will need to be inducted into DMA and military personnel into DoD. This will require the CDS to vigorously pursue enabling amendments to GoI Business Rules and the Central Staffing Scheme.

Secondly, a key military body, the Chiefs of Staff Committee (COSC) has, for decades, been dysfunctional because its Chairmanship is held by one of the three Chiefs on a part-time, rotational basis. Historically, the Chairman COSC has lacked the authority as well as capacity and inclination to tackle tri-Service issues of substance. With the CDS now being designated 'permanent Chairman COSC', he will be able to devote undivided attention to the administration of tri-Service organisations and take measures to engender 'jointness' amongst three Services. In the approaching era of dwindling defence budgets, a crucial function of CDS will be 'prioritising' the capital acquisition proposals (or 'wish-lists') of individual Services. He will have to ensure that the 'defence Rupee' is spent judiciously; on warfare-capabilities considered vital for national military power, and not on pandering to Service demands.

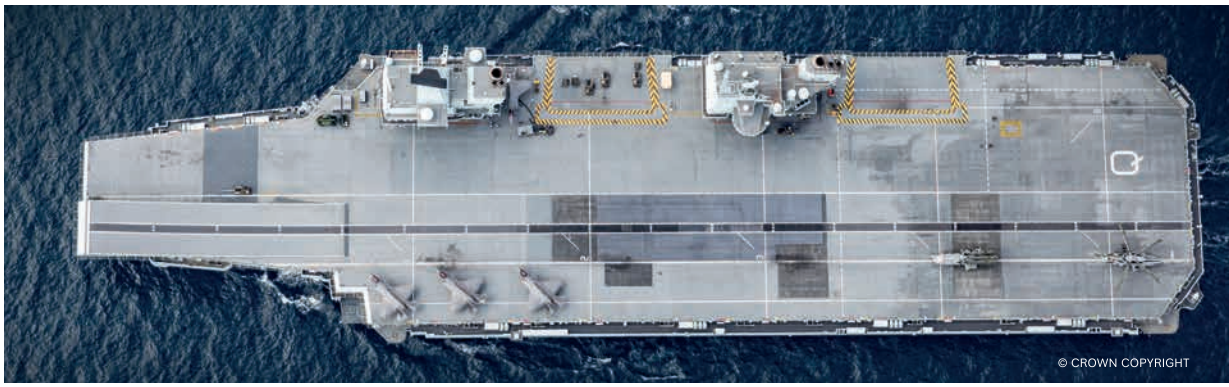
Thirdly, the Chairman COSC is, notionally, a key functionary in the nuclear command chain, but given his rather uncertain status, there was ambiguity about his role in this critical domain. However, this ambiguity has been eliminated with the designation of CDS as PMA to the Nuclear Command Authority. Since the CDS will also administer the Strategic Forces Command, this measure will go a long way in enhancing the credibility of our nuclear deterrent. Given the differing interpretations of India's Nuclear Doctrine voiced by GoI functionaries from time to time, the CDS would do well to initiate an early review of the Doctrine.

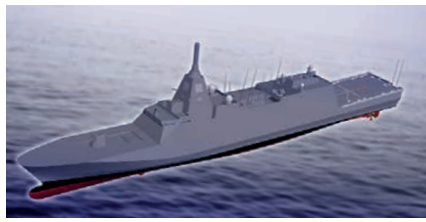
Fourthly, the mandate of the DMA includes facilitation of "jointness in operations" through establishment of Joint/Theatre Commands. Although a successful template for joint operations was created in the Andaman & Nicobar Command (at the mouth of the Malacca Strait) 19 years ago, lack of political direction and indifference of the COSC has led to stasis. While contemplating creation of integrated theatres it must be borne in mind that this will imply operational control of forces devolving from the Chiefs to Theatre Commanders. At the same time, theatre commands would need staff with the knowledge and experience to deploy land, maritime and air forces. Given the disruptive impact of each of these measures, they would best be implemented by the CDS, in a phased manner.

Fifthly, the designation of CDS, a four-star General in the pay-grade of Cabinet Secretary, as head of DMA, may create issues of equivalences, since the other four departments of MoD are headed by Secretary-rank officers. One alternative would be to delegate the financial and administrative powers of CDS to his 3-star Chief of Staff (deputy) and designate him as Secretary DMA. The other alternative would be to emulate the British and bring the Defence Secretary on par with the Chiefs and CDS.

Finally, a reminder is in order that the essence of Jointness lies in the fact that the appointment of CDS (it is not a rank) is tenable by 4-star officers of all three Services. Ironically, the new rank badge created for a CDS, seems designed only for army uniforms and an Admiral or Air Chief Marshal may not be able to wear it.

An error or a 'Freudian slip'?





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OPINION

Brigadier Gurmeet Kanwal outlines

A road map for General Rawat

In what was certainly a surprise announcement from the ramparts of the Red Fort on Independence Day in August 2019, Prime Minister Narendra Modi had declared the government's intention to appoint a Chief of Defence Staff (CDS). A committee headed by National Security Adviser (NSA) Ajit Doval-who also heads the Defence Planning Committee (DPC)-was appointed to work out the modalities and draw up a charter of responsibilities for the CDS. With former Indian Army chief General Bipin Rawat now having taken over as India's first CDS, a long-pending gap in the management of higher defence has been fulfilled.

The creation of the post of CDS was a major recommendation of the Group of Ministers (GoM), headed by former deputy Prime Minister L K Advani, that analysed the Kargil Review Committee report. Several analysts have termed this an incomprehensible omission for which three reasons were cited. First, political consensus on the establishment of the post of CDS was lacking. Second, the civilian bureaucracy was never in favour of the concept of a CDS. And, third, there was some opposition even within certain sections of the armed forces to that idea.

The first item on the agenda of the CDS should be the formulation of *integrated operational plans*. In fact, the CDS should be instrumental in obtaining the defence minister's approval for an integrated tri-service operational directive. It is well known that the operational plans of the armed forces are single-service plans, and they lack the synergy that comes from integrated planning. It is also well known that in 1962, the Indian Air Force was not given any combat role to play during the war with China when it could have made a huge contribution. In 1965, the Indian Navy was not even informed about the plans to launch a three-pronged attack across the international boundary into Pakistan.

It has been repeated *ad nauseum* that the 1971 war was a well-coordinated tri-service effort which than led to a grand victory. The rather limited coordination that was achieved during the war with Pakistan in 1971 was mainly owed to the personalities of the army, navy and air force chiefs. During the 1971 war, Field Marshal Sam Maneckshaw was able to carry his naval and air force colleagues along with him owing to the personal rapport that he had established with them. Yet, there were several glitches in the planning and conduct of the land and air campaigns and it cannot be stated that India fought a coordinated 'air-land' war.

The Indian intervention in Sri Lanka during 1987-90 was a disaster from the joint planning point of view. The Kargil conflict of 1999 is the only real example of a coordinated effort, but even here, there were initial hiccups and it took the IAF several weeks to begin bombing the Pakistani intruders' sangars on the Indian side of the LoC.

Hence, it emerges that operational planning must be seamlessly integrated in modern conventional conflict. After gaining some experience with the CDS-led operational planning, it will be time to graduate to integrated theatre commands to further optimise the planning and execution of joint operations.

Will the appointment of a CDS will have any impact of nuclear command and control? India's prevailing security environment is marked by regional instability with a nuclear overhang. More than ever before, it is now necessary for the national security decision makers to be given "single-point military advice" that takes into account the operational strengths and weaknesses and the interdependence of each of the armed forces on the other, to meet complex emerging challenges in a nuclear environment.

Such advice can come only from a CDS who will be the principal military advisor to the prime minister who heads the Nuclear Command Authority (NCA). The CDS will streamline the operational readiness and employment of India's nuclear forces. While India's nuclear doctrine and policy are guided by the NCA, their execution is entrusted to the services and here a joint approach is mandatory. The Strategic Forces Command (SFC), constituted for the planning, coordination and control of India's nuclear weapons, should function directly under the CDS, even while functional control over the nuclear warheads and the delivery systems comprising the 'triad' remains with the civilian political leadership.

The CDS will have several other important responsibilities as well. Policy planning for the optimum exploitation of aerospace, information warfare, cyber-security and issues such as the management of the electro-magnetic spectrum, including frequency management, electro-magnetic compatibility (EMC), electro-magnetic interference (EMI), electronic emission policy (EEP) and the offensive employment of non-communications devices such as radars for electronic warfare, will all be legitimately the domain of the CDS and HQ Integrated Defence Staff (IDS).

As and when the tri-service Aerospace Command, Cyber Command and Special Forces Command are raised to meet emerging challenges in these fields and to better manage all available resources, they will function directly under the CDS.

On the non-operational side, training institutions such as the National Defence College, the College of Defence Management and the National Defence Academy and organisations such as the Armed Forces Medical Services, Canteen Stores Department and a host of others must be placed under the direct command of the CDS for better synergy in their functioning and optimum exploitation of their potential.

While the CDS must really be the planner-in-chief of integrated operations, the Army, Navy and Air Force chiefs should continue to oversee the development and acquisition of weapons and equipment for their respective services, plan recruitment, guide and coordinate training at specialised training establishments and control administrative matters such as management of the annual budget, pay and allowances, maintenance support and medical services etc. However, a Vice Chief of Defence Staff (VCDS) should also have been appointed to head the newly-created Department of Military Affairs. The present Chief of Integrated Defence Staff should be renamed as the VCDS.

Policy

Air Marshal BD Jayal feels that

Staid practices hamper defence modernisation

A recent panel discussion on 'Make in India and the nation's security' featured General VP Malik, who was Army Chief during the Kargil war. Few will forget his promise to the nation, when faced with a herculean challenge, of "we will fight with what we have", also discreetly conveying the message to civil leadership that the defence management, procurement and production systems had failed to deliver, leaving the Army to fend for itself. Not surprisingly, during the panel discussion, he again cautioned the people that unless India becomes self-reliant in defence, its security forces would continue to be vulnerable.

Another panellist, who had been a senior member in the defence acquisition system, suggested a dedicated and overarching organisation to deliver on defence needs and the panel moderator reflected on the irony that the country has launched ballistic missiles but is unable to make the INSAS rifle. If these are the sentiments of those who have been practitioners, then clearly the self-reliance in defence production, that has been an avowed objective of governments since independence, continues to evade us.

It is worth revisiting recent history to fathom why indigenising defence production is proving to be so challenging to successive defence ministers, all of whom mean well, and of late, appear to have taken positive steps towards this end. In 2015, the government appointed the Kelkar Committee to study the public-private partnership concept and make recommendations. This was followed by the Dhirendra Singh Committee which looked at the *Make in India* concept in the field of defence manufacturing and recommended a strategic partnership model wherein the government would select Indian private enterprises to exclusively make designated military platforms.

Consequently, the ninth version of the Defence Procurement Procedure or DPP-2016 devoted chapter to strategic partnership, which followed soon after. Whilst the idea evokes optimism amongst most stakeholders because of the dynamism that the private sector will bring, as subsequent events including the drawing of the Rafale controversy into the political arena showed, any attempt to involve the private sector in the defence procurement and production domain will continue to be a challenge.

This is borne out by a recent media report highlighting how in six years, no major *Make in India* defence project has taken off because of bureaucratic bottlenecks, commercial and technical wrangling and a lack of requisite political push. These shortcomings have a historical reason, some going back decades and unless we attempt to understand and address these, our *Make in India* vision will continue to stagnate. That the Defence Minister has formed yet another committee to review the DPP-2016, indicates that formulating newer and more complex procedures appears to have become an end in itself rather than merely a means to an end.

The first challenge is to understand that defence manufacturing is in a special category and needs to be treated as such. This is best exemplified by what Jacques S. Gansler, who steered such consolidation in the US, had to say in their context: "In order to understand the economic operations of the US defence industry, it is first absolutely essential to recognise that there is no free market at work in this area and that there cannot be one because of the dominant role played by the federal government. The combination of a single buyer, a few large firms in each segment of the industry, and a small number of extremely expensive weapon programmes, constitutes a unique structure for doing business." Drawing from this experience and applying our own conditions both in the public and private sector, we first need to arrive at our own 'unique structure' of doing business in the field of defence production which must have unanimity across the political system for it to succeed.

The second challenge dates back to the Bofors 'scandal' of 1987 and the attendant political controversy that resulted in a defence procurement eco-system where procrastination has become the mantra. The Services have termed this as the *Bofors syndrome*, a mindset where few in the decision-making chain would venture to take decisions for fear of falling prey to the shenanigans of others in the complex chain of decision-making.

The unique feature of this syndrome is that it works smoothly where government-to-government procurement contracts are concerned, but goes into deep freeze when faced with an open tender purchase. But with the recent political controversy surrounding the government-to-government agreement for the purchase of Rafale aircraft, this avenue may also become a victim to the *Bofors Syndrome.*

The next challenge is to recognise that defence acquisition is a complex process involving multiple stakeholders and involves diverse resources and decision-making systems and should aim to provide on-performance, on-time and on-cost capabilities to the armed forces. This is a mission for committed professionals and not for administrative generalists or, indeed, for uniformed specialists working on rotating assignments, burdened with other chores and pressures. In the US and elsewhere, defence acquisition is considered a full-time profession where people train, specialise and work full-time. The US even has a Defence Acquisition University committed to creating acquisition professionals.

In the foreword to the DPP-2016, Manohar Parrikar had said, "The DPP is not merely a procurement procedure, it is also an opportunity to improve the efficiency of the procurement process, usher in change in the mindset of the stakeholders and promote growth of the domestic defence industry.' The biggest challenge to the *Make in India* aspect in defence production, hence, remains the outdated mindset.

Whatever the official claims, to impartial observers, the underlying spirit of successive DPPs is no longer "delivering and sustaining effective and affordable war-fighting capabilities to users within a specified time frame". Instead, each successive version is being driven by a procedural, legal and defensive mindset where following the book appears to be an end in itself, leaving the armed forces bereft of modernisation and left to "fight with what they have".

Chief of Defence Staff appointed

In a landmark decision on 24 December 2019, which ushers in a "tremendous reform in higher defence management in the country", the Union Cabinet chaired by Prime Minister Narendra Modi approved to create the post of Chief of Defence Staff in the rank of a four-star General. The Chief of Defence Staff will also head the Department of Military Affairs (DMA), to be created within the Ministry of Defence and function as its Secretary.

A week later, on 1 January 2020, former COAS General Bipin Rawat assumed office of the Chief of Defence Staff (CDS) at New Delhi. As the CDS, General Rawat will be Principal Military Advisor to the Raksha Mantri on all Tri-Services matters and will also head the Department of Military Affairs (DMA). "The CDS will have a key role in ensuring optimum utilisation of allocated budget, usher in more synergy in procurement, training & operations of the Services through joint planning and integration. The CDS will facilitate indigenisation of weapons and equipment to the maximum extent possible while formulating the overall defence acquisition plan for the three Services". On 31 December 2019, General Bipin Rawat had handed over the baton of Chief of the Army Staff (COAS) to General Manoj Mukund Naravane (*image above*).

The DMA Structure

The newly created Department of Military Affairs, headed by Chief of Defence Staff (CDS) General Bipin Rawat is to be staffed by some 60 officials including 2 joint secretaries, 13 deputy secretaries, 25 under-secretaries and 22 section officers. The present Joint Secretary (Army) is likely to report to the CDS but all roles are yet to be formalised. In the interim the DMA has posted officers of Major General and equivalent rank as joint secretaries in charge of the Army, Navy and Air Force but there remains the need to clarify the organisation's structure, charter and role.

The CDS will be responsible for jointness in procurement, training and staffing for the Services through joint planning and integration of their requirements. He has been tasked with the facilitation of restructuring military commands for optimal utilisation of resources by bringing about jointness in operations, including through establishment of Theatre Commands.

Reorganisation at Army Headquarters

According to reports from New Delhi, as part of restructuring of Army Headquarters, the new post of Deputy Chief of Army Staff (Strategy) is being created under whom will be the Director Generals of Military Operations (DGMO), Military Intelligence (DGMI), Operational Logistics (DGOL), Perspective Planning (DGPP) and Information Warfare (DGIW). Further, it is understood that the Director General of Rashtriya Rifles (RR) will have his headquarters under Northern Command in Udhampur as bulk of the RR forces are deployed in Jammu & Kashmir.

The present DCOAS (Planning & Systems) will be known as DCOAS (Capability Development & Sustenance) with all capital and revenue procurements being his responsibilities. The Director General Military Training will function under the Army Training Command whose present headquarter at Simla is likely to be moved to Meerut.

CDS calls for "decisive action against terrorism"

In his forthright speech at the *Raisina Dialogue* at New Delhi on 16 January 2020, CDS General Bipin Rawat made it clear that "terrorism will remain as long as there are states that sponsor it …." clearly alluding to Pakistan, this statement being a clear

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and an assertive message to India's neighbouring country. General Rawat was part of the panel discussion on *Poachers as Gamekeepers: Can Terror Incubators Counter Terror*, moderated by Yalda Hakim of BBC World News, herself of Afghan-origin. General Rawat advocated an approach similar to the one followed by America after the 9/11 attacks, that of direct military action even as listing by the FATF and diplomatic isolation could be used for continued pressure.

Some weeks earlier, a US military veteran had written on twitter that if "Americans killed by a foreign proxy group are worthy of revenge when it is Iran providing the support, why is it then when Pakistan is supporting the Taliban and HQN killing Americans in Afghanistan, they get a peace deal and Pakistan gets aid" ? A prominent Afghan entrepreneur in America also openly suggested that the US should target Pakistani Generals "who are responsible with the Taliban for killing of 3,500 US servicemen in Afghanistan".

An integrated Air Defence Command (ADC)

"The establishment of an Air Defence Command (ADC) as part of the re-structuring of Indian Armed Forces will usher a paradigm change in the defence establishment". Chief of Defence Staff (CDS) General Bipin Rawat has directed that the ADC should be established by 30 June 2020, integrating the various air defence formations of various Services. The new COAS General Manoj Mukund Naravane too has stated that "formation of an Air Defence Command will ensure such blue-on-blue incidents do not happen. Can say with a reasonable degree of confidence, such incidents will not take place after the Air Defence Command is set up". He was referring to the unfortunate shooting down of an IAF Mi-17 in Budgam on outskirts of Srinagar on 27 February 2019 and the recent shooting down of an Ukranian airliner over Tehran in January 2020.

The United States had formed its Air Defence Command (ADC) way back in March 1946, which involved integrating of radar stations

and control centres with dedicated fighter squadrons and air-to-surface missile formations for air defence of the continental United States, the ADC being reinforced later with inclusion of AWACS and space-based assets.

IAF inducts FIS Dornier 228s

Air Chief Marshal RKS Bhadauria formally inducted a batch of Dornier 228s equipped for Flight Inspection (FIS) with No. 41 Squadron ('Otters'), at a ceremony on 31 December 2019. The specially-equipped HAL-Dornier 228s will undertake calibration of navigational aids at IAF air bases throughout the country, which have been enhanced via the *Modernised Airfield Infrastructure* (MAFI) programme. The first of these aircraft was formally handed over by Mr Sajal Prakash, CEO Accessories Complex HAL at Air Force Station, Palam. No.41 Squadron has been operating HAL-Dornier 228s from the mid-1990s in the communication, staff transportation and light logistics support role.

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IAF R-Day flypast, 2020

Comprising IAF's fly past formations on Republic Day 2020, were 19 helicopters, 9 transport aircraft and 16 fighters. Leading the parade were four Mi-17V5s followed by four Dhruv ALHs (Army Aviation), then three Rudra ALH Mk.IVs of the Air Force, three CH-47 Chinooks and finally five AH-64 Apaches. The transport tranche were led by three Dornier 228s, followed by three C-130J Super Hercules, then three C-17 Globemaster IIIs and a single Netra AEW&C aircraft flanked by two Su-30MKIs. Five Jaguars were followed by five MiG-29s, with four Su-30MKIs carrying out vertical Charlie manoeuveres as the climax.

More Apaches air-delivered

Antonov Airlines have been contracted to transport four Apache AH-64E attack helicopters from Phoenix Mesa Gateway Airport, to Hindan Air Force Station in India. An Antonov Airlines An-124-100 transported the helicopters, with a total payload of 39 tonnes including the aircraft's dismantled rotor blades.

Integrated Battle Groups being exercised

The COAS General Manoj Mukund Naravane is confident that the planned Integrated Battle Groups (IBGs) will take 'final shape' in the next 18 months after requisite Government clearances. The Army reportedly begun exercising the IBGs in mid-2019, first under IX Corps in Western Command and later in October 2019 under XVII Corps in Eastern Command. The COAS stated that reports were "very encouraging" and that "lessons have been learnt". The concept of composite IBGs will have a major impact on the structure of combat arms, infantry, armour, artillery and other support units, but since every IBG will be formed to counter threats envisaged in particular terrain, this will impact on the Army's existing operational structure.

The creation of agile and self-contained IBGs, each with some 5,000 soldiers with a varying mix of infantry, armour, artillery, air defence, signals, engineers and other support units, is part of the ongoing restructuring of the 1.3 million strong Indian Army. Each IBG will be commanded by a Major General and configured as per the type of threat, terrain involved and task to be achieved.

L&T delivers 51st K9 Vajra-T howitzer

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by Defence Minister Mr Rajnath Singh at their factory in Hazira (Gujarat) on 16 January 2020. As Mr AM Naik, Group Chairman L&T said "Our Defence team has once again demonstrated L&T's engineering and execution prowess in building this most advanced weapon system to the exacting levels of quality while ensuring on time delivery. The Hazira Manufacturing Complex has set various international technology and manufacturing benchmarks and the K9 Vajra is certainly one of them".

Army Chief visits Siachen Glacier

On his very first visit to forward areas after taking over as Chief of the Army Staff (COAS), General Manoj Mukund Naravane visited the Siachen Glacier on 11 January 2020, the Glacier acting as a wedge between the Shaksgam valley under Chinese control and Baltistan that is occupied by Pakistan which blocks the two armies from linking up and posing a threat to Ladakh. The General stressed this factor : "As far as the land border is concerned, Siachen is where the two countries (China and Pakistan) are the closest to each other. And that is why the threat of collusively is maximum at that location, that is, in Siachen and the Shaksgam valley".

COAS on a 'two front war'

Concerned with the scenario of a 'two front war', the COAS stated that "in case of simultaneous threat from both directions, there would always be a primary front and a secondary front. Wherever the primary front is, the bulk of our forces and resources will be concentrated to deal with that threat. And on the other front, we will adopt a more deterrent posture so that we are not found wanting on either account". In any event, the Army has 'dual task formations' that are able to swiftly be moved from the western to the eastern front and vise-versa to deal with all emerging threats. General Naravane said that significant capacity building was happening along the northern borders with China as part of the re-balancing exercise, including the deployment of advance weapons in the country's East. "We are going in for a lot of capacity-building and that includes creating roads to forward areas, creating capacities in terms of habitat, storage for ammunition, moving some of our more advanced weapon systems towards the eastern side. We are balancing out so that we are able to meet a threat from any direction".

Lt Gen Ranbir Singh visits China

Terming the five-day visit to China in early January 2020 by a high level Indian Army delegation led by Lt Gen Ranbir Singh, GOC-in-C, Northern Command to China as "successful", an Army spokesman said that the interactions "will pave the way for enhanced cooperation in defence sector between the two countries and peace at the borders". The visit to China culminated at Shanghai after visits to important military establishments in Beijing, Chengdu, Urumqi and Shanghai. There were meetings with senior PLA Commanders including General Han Weiguo in Beijing. Lt Gen Ranbir Singh and delegation thereafter visited China's Western Theatre Command at Chengdu where talks were held with General Zhao Zongqi, and concerned the Sino-Indian borders. Lt Gen Ranbir Singh later visited the Combined Brigade under 77 Group Army and later interacted with Lt General Liu Wanglong, Commander Xinjiang Military Command as also the 9 Engineer Regiment.

"The visit is also seen as progression of the spirit of Wuhan and Chennai Summits. The visit of the delegation will surely foster the spirit of friendship and enhance the strategic military relationship between the two countries," the spokesman said.

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Surveillance systems along LAC

According to reports from New Delhi, the Army is to set up high-tech surveillance cameras along the *Line of Actual Control* on the northern frontiers with China, while also focusing on establishing war-time and weather-proof aircraft shelters in North-Eastern India. Following their visit to the outposts, a Committee of the MoD has reportedly urged that the immediate requirement for surveillance equipment for the Eastern Command and northern borders, including at Nathu la, be fulfilled "at the earliest".

CNS "concerned" over Navy budget

Concerned with China's vigorous naval expansion, the CNS Admiral Karambir Singh has flagged concerns over decline in the Indian Navy's share in the defence allocation which has reduced from 18% in 2012-13 to 13% in 2019-20. The Navy's long-term capability plan projects the need for three aircraft carriers so that two carrier battle groups can be deployed in the Indian Ocean Region at any time. The CNS said the first indigenous aircraft carrier (IAC) will be fully operational by 2022 and will embark MiG-29K fighters. The second, (IAC II) will be a 65,000 ton CATOBAR aircraft carrier with electric propulsion and the Navy will shortly approach the government seeking approval for the project.

As for the *Indo-Pacific* region, the CNS re-iterated that the Indian Navy "was ready to work with like-minded nations based on common interests of ensuring safe and secure seas and promote rules-based order. Moreover, the quadrilateral coalition of India, the US, Japan and Australia does not have a military role in the Indo-Pacific region at the moment".

Navy's first Woman Pilot

A batch of three trainee officers of the 7th Dornier Conversion Course (DOCC) included a lady officer S/Lt Shivangi, who qualified as Dornier pilots and were awarded their *Golden Wings* at a ceremony at INS *Garuda*. Vice Admiral AK Chawla, the Flag Officer Commanding-in-Chief (FOC-in-C), Southern Naval Command was the Chief Guest for the ceremony.

The award of 'Wings marks culmination of one years' flying training at the Air Force Academy, Dundigal and Indian Naval Air Squadron (INAS) 550, at INS *Garuda* in Kochi. These pilots would join the 'Dornier Operational Flying Training' course at INAS 550 in mid-January 2020, prior to joining an operational maritime reconnaissance squadron.

Weapons and Sensors for 'Project 15-B' destroyers

The Cabinet Committee on Security (CCS) has cleared the weapons and sensors package for the four *Project 15-B* destroyers now being built-at Mazagaon Dockyards, Mumbai. The package, which includes BrahMos supersonic cruise missiles, Barak 8 LR-SAMs, 127mm guns and rocket launchers plus MF-STARs radars is for approx. Rs 6150 crore. The lead ship is INS *Visakhapatnam,* to be commissioned in 2021-2022 followed by INS *Mormugao* and INS *Imphal* plus an unnamed a fourth, these being of 7,300 tonnes and powered by four gas turbines.

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Indian Coast Guard ships commissioned

Two new Indian Coast Guard Ships (ICGS) — *Annie Besant* and *Amrit Kaur* — were commissioned by Defence Secretary Dr. Ajay Kumar at Kolkata on 12 January 2020. Director General K Natarajan, ADG and Coast Guard Commander (Eastern Seaboard) VS Pathania and others were present during the ceremony. Both ships are 48.9 metres long and 7.5 metres wide, with a displacement of 308 tonnes, powered by MTU 4000 series engines and propelled by three 71S type III Kamewa water jets by Rolls Royce, having a maximum speed of 34 knots. The ships will be tasked for maritime surveillance, interdiction, search and rescue, and medical evacuation.

Bangladesh Navy Chief at SNC

Admiral Aurangzeb Chowdhury, Chief of the Naval Staff, Bangladesh Navy accompanied by staff officers, visited Kochi on 10 December 2019 and had interaction with Vice Admiral AK Chawla FOC-in-C, Southern Naval Command. Various areas for enhancing cooperation between the two navies, especially in the field of training, were reportedly held.

The CNS Bangladesh Navy also visited INS *Dronacharya*, Cochin Shipyard Limited, Diving School, INS *Tarangini* and INAS 550 at INS *Garuda*.

'Apharan' anti hijacking exercise off Kochi

The Indian Navy, the Indian Coast Guard, Cochin Port Trust and other concerned stake holders, conducted a large scale Anti Hijacking Exercise off Kochi on 18 December 2019, the first time such a large scale exercise involving all stake holders was conducted in Kerala. Exercise *Apharan* had participation of multiple agencies, with more than 12 ships and helicopters of the Indian Navy, Indian Coast Guard and Cochin Port Trust. Interdiction of a 'rogue' vessel outside Kochi port and insertion of Marine Commandos onto the vessel through boarding operations from a Sea King helicopter, were exercised.

"IAF's role critical" : CAS

Speaking at the Combined Graduation Parade held at Air Force Academy, Dundigal, the CAS Air Chief Marshal RKS Bhadauria stated that the Indian Air Force will continue to play a critical role in the security domain. "The present decade is likely to witness significant changes in nature and methodologies of warfare particularly in the sub-conventional domain".

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Dedicated Su-30MKI + BrahMos Squadron

On 17 December, 2019, the IAF had carried out the third successful firing of the BrahMos supersonic cruise missile from a Sukhoi Su-30MKI. This was in a 'user configuration', thus completing the firing trials programme and clearing it for operational deployment. The first dedicated Sukhoi Su-30MKI squadron integrated with the BrahMos supersonic cruise missile was formed on 20 January 2020 and based at Thanjavur, formerly Tanjore, in Southern India, famous for its ancient Chola-dynasty culture, with many historic temples and paintings.

No.222 Squadron (*Tigersharks*) which had earlier operated MiG-27s and was number plated after the type was phased out, has been re-raised and is located at this new air station in the maritime strike role, with its air-launched BrahMos having range of some 300 kms. The Su-30MKI themselves have very long range which can be extended by mid-air refueling, endowing capability of striking at maritime targets at considerable distances from the Indian mainland.

"200 new fighters to be acquired"

Defence Secretary Dr. Ajay Kumar has stated that the Government is in "the process of acquiring around 200 fighters to cope with the depleting inventories of the Indian Air Force". Of these, 83 would be LCA Mk.1As while the *Expression of Interest* for acquisition of 110 multi-role fighters, released sometime back, will be followed by the Request for Proposal (RFP) to selected OEMs. In this context are reports from Bangalore which have flagged the dwindling orders with Hindustan Aeronautics Limited whose production facilities "would be idle from 2021-22 unless new business is generated."

"Make in India work must be expedited" : CAS

In his candid statement, Air Chief Marshal Rakesh Kumar Singh Bhadauria, CAS has said that lip service was being done regarding the 'Make in India' programme when it came to developing and producing indigenous equipment. Speaking at an event in New Delhi, the Air Chief said that over the next 16-18 years, the IAF would require over 300 fighters, some made by HAL but at the present pace of 11-12 aircraft a year, HAL will take over 25 years to make variants of the LCA Mk.1 and Mk.II, followed by the 5th generation AMCA. "The IAF wants HAL to ramp up production to 16 aircraft per year and out source work to increase this to 20 a year". He also said "we have given our support and the DRDO has to come up with the timeline".

India-US 2+2 Dialogue

Indian Defence Minister Rajnath Singh and External Affairs Minister S Jaishankar met with US Secretary of Defense Dr Mark T Esper and Secretary of State Michael R Pompeo in Washington DC on 18 December, 2019 for the second annual India-US

2+2 Ministerial Dialogue. This is the highest-level institutional mechanism between the two countries and provides for a review of the security, defence and strategic partnership between India and the United States. Both countries reportedly appraised the growing partnership between India and the United States and noted that important milestones had been achieved since the inaugural 2+2 dialogue in New Delhi in 2018. Both sides also committed to further deepen military-to-military cooperation, including those between the Indian and US Navy under the US Indo-Pacific Command, Central Command and Africa Command and intend to expand similar cooperation between their respective Armies and Air Forces. A number of other initiatives to enhance military-to-military cooperation were also reportedly also agreed upon.

US-India Industrial Security Annex

On 20 December 2019, an *Industrial Security Annex* (ISA) agreement was signed between Indian Defence Minister Rajnath Singh and US Secretary of Defense Dr Mark T Esper, on sidelines of the 2+2 ministerial dialogue to review the security, defence and strategic partnership between India and the USA. The countries have identified three joint projects, which include air-launched unmanned airborne systems, lightweight small arms technology and innovations in the field of intelligence, surveillance, targeting and reconnaissance. Mr Rajnath Singh stated that "The ISA provides the framework for pursuing co-development and co-production linkages in the defence manufacturing sector," India has pledged legal safeguards for US firms working on latest technologies with Indian companies, and priority initiatives have been identified for execution under the Defence Technology and Trade Initiative (DTTI) programme (*above image for representation purposes)*.

BrahMos for South East Asian nations ?

It is reported that the Philippines could well be the first South East Asian nation to procure the BrahMos supersonic cruise missile jointly developed by India and Russia. Following the 2017 visit to the Philippines by Prime Minister Narendra Modi, the two countries had signed a protocol for strengthening cooperation and coordination in logistics support and services.

Meanwhile, the Thai Ambassador to India has stated that his country was hoping to conclude negotiations on the purchase of BrahMos missiles in 2020. India is also exploring the possibility of selling the BrahMos to Indonesia, whose Navy is considering integration of the BrahMos on Indonesian warships at the state-run shipyard in Surabaya.

Pinaka missiles test-fired in salvo

As part of flight trials of the Pinaka missile system, two test firings by the DRDO were conducted on 19 December 2019, from the Integrated Test Range, Chandipur, off the Odisha coast. The mission objective of these trials was to test functioning of the live warhead along with its proximity initiation and salvo launch. Two Pinaka missiles were launched in salvo mode with 60 seconds interval between two firings, both missiles to engage a target located 20 kilometre away "and high accuracy was achieved".

The Pinaka MK-II rocket has been modified integration of with a navigation, control and guidance system to improve end accuracy and enhance range. Navigation system of the missile is also aided by the Indian Regional Navigation Satellite System (IRNSS).

BrahMos missiles launched

On 17 December 2019, the DRDO, IAF and BrahMos successfully launched two supersonic cruise missiles, one each from land and air platforms. The first missile launch was from a land based mobile launcher, where most of the components were indigenous, including the missile airframe, fuel management system and DRDO designed seeker. The second launch was carried out by an Indian Air force Su-30MKI against a sea target. The test conducted in user configuration, revalidated the ship attack capability of the advanced air-launched cruise missile, during which the missile was gravity dropped from the aircraft and the two-stage weapon's engine ignited, and the missile propelled towards the intended target at sea (see news item.)

QRSAM flight-tested

On 23 December 2019, a Quick Reaction Surface-to-Air Missile (QRSAM) system developed by the DRDO was successfully flight-tested from the ITR at Chandipur. The missile was in full configuration deployment mode, intercepting the target mid-air, the event monitored by Ground Telemetry Systems, Range Radar Systems, Electro Optical Tracking System etc.

The QRSAM weapon system, which is mobile, comprises an automated Command and Control System, Active Array Battery Surveillance Radar, Active Array Battery Multifunction Radar and Launcher, both radars having 360-degree coverage with search-on-move and track-on-move capability. The single stage solid propelled missile has midcourse inertial navigation system with two-way data link and terminal active seeker developed indigenously by the DRDO.

Financing for Russian-origin equipment

The Government of India is reportedly working on alternative routes to finance supplies of equipment and weaponry ordered from Russia which have been complicated owing to the threat of US sanctions. The new route follows merger of the Syndicate and Canara banks as the State Bank of India has been apprehensive that transactions to Russia could attract sanctions. Major projects for which payments will be made to Russia include for the S-400 system, leasing of another nuclear attack submarine, procurement of four stealth frigates, as also for Kamov Ka-226 light helicopters apart from the Army's massive requirement of AK-203 assault rifles.

Indian Army's SPAD-GMS requirement

The Indian Army has requirement for 5 regiments of self-propelled air defence gun missile systems (SPAD-GMS) which can be deployed along with advancing mechanised forces for air defence against enemy threats. According to sources in New Delhi, following extensive trials in varying terrain, the Russian upgraded Tunguska M1 and Pantsir missile systems and South Korea's K-30 *Biho* (*Flying Tiger*) were in competition. The later system, produced by Hanwha Defence was initially selected but there have been several objections from the Russian side including a formal complaint to the MoDs internal monitoring committee.

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AK-203 standard rifles for Army...

The Indian Army has an urgent requirement to replace its standard INSAS (of 5.56mm calibre) with a 7.62 mm weapon that has longer ranger and higher kill probability. After a long drawn process, the Russian AK-203 assault rifle was selected. These will be manufactured indigenously by Indo-Russian Rifles Private Limited (IRRPL) at Korwa in Uttar Pradesh, headed by Major General Sanjeev Senger as Chief Executive. Some 100,000 rifles are to be imported on 'fast track' while the balance 650,000 would be produced in India, the facility being set up between the Ordnance Factories Board (OFB) and Kalashnikov Rosoboronexport, the OFB owning 50.5% equity and the Russians 49.5%.

... and SIG-716 assault rifles

Apart from the AK-203 as the standard infantry weapon, the Indian Army has begun receiving first batches of SIG-716 assault rifles, which are earmarked for troops engaged in counter insurgency operations in the Northern Command area. Contract for the rifles were signed with the American company Sig Sauer in February 2019, involving 72,400 SIG-716 assault rifles worth Rs 700 crore . The bulk of these are for the Army but 4,000 will be for the IAF and 2,000 for the Indian Navy.

Night Vision devices for LMGs

The Indian Army has an urgent requirement for advanced night vision devices for their rifles and light machine guns. The advanced night-vision device (ANVD) is an opto-electronic system which provides high resolution images of the area in the user's field of view in conditions of very low light or total darkness. The Army's requirement is for the device to detect a human at a distance of at least 500 m and a vehicle at 1,200 m and should enable the user to identify them at a distance of 350 m.

Vistara to add 12 airliners by March 2020

Vistara's Chief Executive Leslie Thng has stated that the Tata-SIA airline "will add a dozen airliners in 2020 to supplement a fleet of 42 by March-end, with which it aims to create a unique 'hub-and-spoke' arrangement linking its domestic and international operations. Mr Thng also mentioned that "Domestic operations play two roles for us. One is catering to the full-service demand and second is catering to the international operations, especially on the wide body…the airline plans to induct all six new Dreamliners by 2021, while it would take the delivery of the Airbus A320 family airliners by 2023 : the airline is continuously reviewing its fleet expansion plans—including taking aircraft on lease—depending on market opportunities".

The fleet expansion involves induction of the Boeing 787-9 plus more Airbus A320 and A321 aircraft into the airline's fleet, which will be utilised across its domestic and international operations. The airline currently has 26 Airbus A320s and nine Boeing 737-800NG aircraft in its inventory.

Possible flight disruptions for Air India

Air India's Chairman Ashwani Lohani has warned of flight disruptions and possible invocation of government guarantees because of delays in fundraising and refinance of aircraft debt. Air

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India is seeking government approval to raise a Rs 2,000-crore loan and refinancing of its $819-million aircraft debt, which would help tide over the financial crisis. "The overall financial situation of the airline is grossly untenable and it may not be able to sustain physical operations in the absence of immediate government intervention and support".

Air India had received an offer from a consortium of four banks to refinance the $819 million bridge loan taken for acquiring six Boeing 787s and one Boeing 777 aircraft. Air India sustained a loss of Rs 8,556 crore in the last financial year and the airline continues to suffer despite increase in revenue and yields. New domestic and international flights, too, have been launched but delays in fund infusion has also resulted in continued grounding of 12 Airbus A320s.

Government prepares for AI sale

According to a senior finance ministry official, the draft share purchase agreement (SPA) for Air India along with Expression of Interest (EoI) is being readied. "A lot of potential investors raised questions at the pre-bid stage after the EoI was released. Investors should have more transparent information at the very beginning. Through the draft SPA, they could know the details of liabilities including employee costs, their benefits and the dos and don'ts. The more preparation we do now, the more time we save later. What matters is closing of the deal" .

Meanwhile, to reduce the debt burden on Air India, the government has transferred around Rs 29,464 crore to Air India Assets Holding Ltd (AIAHL), a special purpose vehicle (SPV) meant to park some of the airline's debt not backed by any asset, non-core assets and other non-operational assets.

IndiGo achieves 1500 daily departures

In line with its expansion strategy, IndiGo has achieved a remarkable milestone with 1500 daily departures across its network of 83 domestic and international destinations. IndiGo expanded their operations to 11 domestic and 8 international new destinations inclusive of multiple exclusive and virgin routes, increasing its portfolio by 22 percent between January to December

2019. The airline was the first Indian carrier to connect India with Istanbul in Turkey, Chengdu in China and Hanoi and Ho Chi Minh City in Vietnam while foraying into other countries including Saudi Arabia (Riyadh) and Myanmar (Yangon).

"2019 witnessed many achievements including IndiGo's entry into Europe through a direct connection to Istanbul and the codeshare with Turkish Airlines, another codeshare agreement with Qatar Airways, mega orders of 280 CFM engines and 300 Airbus aircraft to fuel the airline's growth in the 2020s, joining IATA as a member, receipt of the first A321neo, celebrating IndiGo's 13th anniversary and introduction of new in-flight services to enrich customer experience". With its fleet of over 240 aircraft, the airline offers 1500 daily flights and connects 60 domestic destinations and 23 international destinations.

UDAN-4 to enhance air connectivity

Although in the first three phases of UDAN (*Ude Desh Ka Aam Nagrik*), only 232 of the 688 routes awarded were operationalised by select companies, the Ministry of Civil Aviation has now launched the fourth phase to promote air connectivity to other remote and regional areas of the country including the north east, J&K, Ladakh and the offshore Islands. These include Campbell Bay, Car Nicobar and Shibpur in the Andaman & Nicobar Islands, Alinya, Along, Daparizo and Mechuka in Arunachal; Darrang, Dinjan, Ledo and Misra Mari in Assam; Akhnur, Chamb, Chushal,

Poonch, Rajouri and Udhampur in J&K; Shella and Tura in Meghalaya; Kailashahar and Kamalpur in Tripura and Gaucher in Uttarakhand. Apart from these are Kurnool in Andhra; Mudra in Gujarat; Bokaro in Jharkhand; Amravati, Sindhudurg and Ratnagiri in Maharashtra; Ludhiana and Pathankot in Punjab; Kota in Rajasthan; Rourkela in Orissa; Salem in Tamil Nadu; Faizabad (Ayodhaya) and Saharanpur (Sarsawa) in UP and Hashimara in West Bengal.

EOI for Saras Mk.II development

National Aerospace Laboratories, part of the CSIR have formally issued an 'Expression of Interest' for engineering services and technical support in the development, flight testing and certification of the 19-seat Saras Mk.II light transport aircraft. In their presentation to the Parliamentary Standing Committee on Science & Technology, NAL Director Jitendra J Jadhav outlined the plans for development and commercial production of the Saras Mk.II which would meet needs of the UDAN scheme. NAL has pitched for a 50-60 aircraft order from Government agencies so as to make the programme viable.

According to the EOI, first flight of the Saras Mk.II should be some 30 months following "go ahead" with DGCA certification to be received in the 48th month.

FSTC receives DGCA certification

Flight Simulation Technique Centre (FSTC) is the first ATO in the region to induct a Level-D Full Flight ATR72-600 simulator, with DGCA certification to its ATR72-600 simulator. The FFS simulator has an electric-pneumatic motion system allowing for silent operations and reduced power consumption, with a front projection collimated 200°x40° FOV visual display system. The simulator has been installed at FSTC's newly built Hyderabad Facility. IndiGo is the first official customer and have already started using the new device to train their ATR72-600 pilots.

Capt Sanjay Mandavia, CEO of FSTC stated, "With the addition of this simulator we are one step closer to our vision to be Asia's leading ATO with a positive outlook on the market for training pilots both locally here in India as well as in the region."

International Airport at Mopa in Goa

The Supreme Court has given 'go-ahead' for the construction of a *greenfield* international airport at Mopa in northern Goa, lifting the suspension it had imposed on environmental clearance (EC) in March. It has ordered that the construction is subject to strict compliance with the conditions recommended by the Union environment ministry's expert appraisal committee (EAC). The construction would be carried out under supervision of the National Environmental Engineering Research Institute (NEERI). Work on the Rs 3,000 crore project for Goa's second airport will be spread over 2131 acres at foothills of the Western Ghats which will provide much relief to airlines which have restricted timings for operations from the present airport at Dabolim which is essentially a naval air station, INAS *Hansa*.

Six more airports for privatisation

The Airports Authority of India (AAI) have sent proposals to privatise six more tier-two city airports, including Amritsar, Varanasi, Bhubaneswar, Indore, Raipur and Trichy. In February2019, the government had privatised airports at Lucknow, Ahmedabad, Jaipur, Mangaluru, Thiruvananthapuram and Guwahati for operation, management and development through public-private partnership (PPP) model. "As six airports have already been privatised, the AAI has decided to privatise six more airports," a senior aviation sector official stated. Currently, the AAI owns and manages more than 100 airports.

HAL continues production of Dornier 228s

HAL presently has firm orders for 24 more LCA Mk.1s, while the remaining orders for Sukhoi Su-30MKIs will be met over the next two financial years. Once the HTT-40 basic trainer is cleared for series production, HAL expect orders for some 70 of the Type even as HAL's Kanpur Division is manufacturing Dornier 228s for the IAF and IN "in steady numbers".

"HAL not excluded from NUH programme"

Despite efforts by HAL its for inclusion in the MoD's list of OEMs to be considered for manufacturing Naval Utility Helicopters (NUH) it is learnt that the project for 111 numbers, being processed under the "strategic partnership model", is still being limited to the private sector, with Tata, M&M, Adani and Bharat Forge identified as companies that meet the MoD's criteria. The foreign OEMs are Airbus, Sikorsky and Kamov as technology partners. However, a former CIDS and now consultant to the MoD has advised against the exclusion of HAL, citing Para 23 of Chapter II of the DPP 2016.

Safran considers MRO unit in India

As per company sources, Safran is considering a $150-million investment in a new aircraft engine maintenance, repair and overhaul (MRO) unit in India to support its airline customers. Safran and GE Aviation own a 50 per cent stake each in the US-based CFM International, which manufactures engines for the Airbus A320 and Boeing 737 aircraft. Recently, CFM International won a $20-billion order from IndiGo to supply engines for 280

Airbus A320neo. "Given fast expansion of the CFM fleet in Asia and specifically, in India we are considering the possibility of building a new Safran shop in this region of the world to address the growing MRO needs. This new shop will represent an investment of more than $150 million".

HAL and Wipro 3D MOU

In the first such collaboration in India for Metal 3D Printing, HAL and Wipro 3D, the metal additive manufacturing (AM) business of Wipro Infrastructure Engineering (WIN), have signed an MOU to design, develop, manufacture and repair aerospace components using *Metal Additive Technology*. This MoU also accentuates development, prove out and application of new material for use in Metal Additive Technology.

Mr. Shekhar Shrivastava, CEO Bangalore Complex, HAL, said, "This initiative between HAL and Wipro 3D will create a unique synergy of capabilities that can accelerate the adoption of metal additive manufacturing in aerospace in India. Qualification of parts for aerospace is challenging as it would require prove out and extensive testing followed by certification by regulatory authorities which may also include flight testing. This cooperation would be a unique opportunity for both the parties. Metal 3D printing has the potential to play a significant role in the success of national aerospace and defence platforms including HAL's own needs". In the picture are Mr K Rajamani, GM Engines, HAL and Mr Ajay Parikh, Vice President & Business Head – Wipro 3D signing the MoU.

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Photo credit U.S. Marine Corps

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GKN Aerospace inaugurate wiring facility in Pune

GKN Aerospace have officially opened a new facility for Electrical Wiring Interconnection Systems (EWIS) in Pune. The site will focus on the assembly of wiring systems for commercial aircraft and aero-engines including the Airbus A320neo, Boeing 737, 777X and Boeing 787. The Pune facility will operate alongside the existing JV wiring systems in Bangalore, which serves the defence market.

BEML's future status

The Government has given 'in-principle' approval for strategic disinvestment of BEML Ltd. to the extent of 26% from the Government shareholding of 54.03% with transfer of management control to the strategic buyer. The Transaction Advisor, Legal Advisor and Asset Valuer were thereafter appointed by the Government as per the procedure and mechanism laid down for this purpose. The Expression of Interest & Preliminary Information Memorandum documents have been prepared by the appointed Advisors and submitted to the Government.

AXISCADES in key engagement with Airbus

AXISCADES have been selected by Airbus to work on fuselage, product development and customer support services across different Airbus locations. This is the third time Airbus has selected AXISCADES for critical engineering services, the contract being won against stiff global competition across major engineering services firms across the industry.

Adani expands defence business

The Adani Group has continued acquisition of companies engaged in production of defence items. These include a recent takeover of Punj Lloyd's stake in the joint venture with Israel Weapon Industries (IWI) to manufacture a range of weaponry including the Tavor Assault Rifle, the X 95 Assault Rifle, Galil Sniper Rifles, Negev LMGs and Uzi submachine guns. In 2019, Adani Defence acquired 51 per cent stake in a joint-venture with Israel drone manufacturer Elbit for manufacture of the Hermes UAV. Earlier in 2018, the Adani Group also took over majority state in the Bengaluru-based firm Alpha Design technologies.

Exercise 'Hand-in-Hand 2019'

Eighth edition of the India-China joint training exercise *Hand-in-Hand* 2019 culminated on 20 December 2019 at the Joint Training Node at Umroi, Meghalaya. The exercise aimed at joint drills for counter terrorism operations in semi urban terrain under United Nations mandate. The exercise entailed firing of various weapons, conduct of tactical lectures and demonstration by both countries with respect to various aspects of counter terrorism operations. The exercise culminated with a ceremony where participating troops displayed high standards of military drill and reviewed by Major General JS Sandhu and Major General Li Shizong.

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Exercise 'Mitra Shakti-VII' 2019

Seventh edition of Exercise *Mitra Shakti* 2019 aimed at enhancing interoperability and operational efficiency amongst the armies of both India and Sri Lanka, deployed as part of United Nations Peace Keeping Forces took place from 1 December at the Aundh Military Station, Pune. Objective of the exercise was to build and promote positive relations between armies of the two countries through focus on sub unit level training on counter insurgency and counter terrorism operations in urban and rural environment under United Nations mandate.

Indo-Nepal Joint Military Exercise 'Surya Kiran-XIV'

Exercise Surya Kiran-XIV, a joint military training exercise between India and Nepal was conducted in mid-December at Nepal Army Battle School (NABS), Salijhandi, Rupendehi district of Nepal, wherein troops of both Armies participated in 14 days long joint training based on counter insurgency operations in jungle and mountainous terrain and also practised response mechanism in the eventualities of natural and manmade disasters.

During final phase of the exercise, Major General Gopal Gurung, Head of Indian Observer Mission was observer and Lieutenant General Sharad Giri, Chief of General Staff, Nepal Army was the chief guest.

2nd Indo-Russian Tri- Services Exercise (Indra 2019)

INDRA 2019, the Joint Tri Services Exercise between Indian and Russian Armed Forces was conducted 10-20 December 2019 simultaneously at Pune and Gwalior for the Air Force elements.INDRA exercises are regularly held initially being a bilateral single service exercise between India and Russia. The first-ever Joint Tri Services Exercise was held in the Eastern Military District of Russia in October 2017. This time were also fielded Su-30MKIs, Jaguars, Mi-17 helicopters, A.50 AWACS and Garud special forces.

The Sea Phase involved warships including INS *Aditya* and RuFN ship *Yaroslav Mudry* from Mormugao harbour (Goa). INS *Tarkash*, INS *Aditya* and RuFN ship *Yaroslav Mudry* later participated followed by an air defence exercise involving MiG-29Ks of the Indian Navy.

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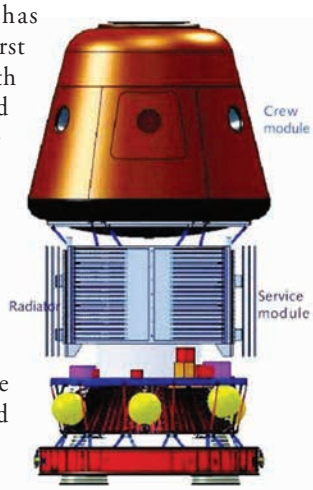
PSLV launches RISAT-2BR1

On 11 December 2019, in its fiftieth flight PSLV-C48, India's Polar Satellite Launch Vehicle, successfully launched RISAT-2BR1 along with nine commercial satellites from the Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. The RISAT-2BR1 was successfully injected into an orbit of 576 km and subsequently, nine commercial satellites were injected into their intended orbits. After separation, solar arrays of RISAT-2BR1 were automatically deployed and the ISRO Telemetry Tracking and Command Network at Bengaluru assumed control of the satellite.

ISRO plans manned space flight

ISRO Chairman K Sivan has revealed plans for India's first manned mission in space, with four IAF test pilots shortlisted for the *Gaganyaan* mission. The selected Indian astronaut will be sent into low earth orbit at 2000 kilometers, the mission planned for December 2021. "We are designing the mission for three people to go to low earth orbit for seven days. However, whether we send two people or one person and whether they spend seven days in the orbit or one will be decided later on in the mission after the two unmanned flights. Usually, the first flight is very crucial and even countries such as the USA, Russia and China sent only one person for the first time and for a very short time – one orbit, or one day, or even did only part of the orbit" he said.



ISRO's most powerful launch vehicle, the GSLV Mk.III, referred to as *Bahubali*, will propel the manned module into space, being redesigned to have a four-metre payload faring on top. The mission is to be launched from the second launch pad at the Satish Dhawan Space Centre at Sriharikota.

ISRO launches CARTOSAT-3

The Indian Space Research Organisation has successfully launched CARTOSAT-3 along with 13 commercial nano-satellites from the United States. CARTOSAT-3, India's most complex and advanced earth imaging satellite built so far, was placed into orbit 17 minutes and 46 seconds after the lift-off, all 13 nano satellites from the US released into the orbit at 26 minutes and 56 seconds after liftoff.

According to ISRO Chief K Sivan "CARTOSAT-3 is India's highest resolution civilian satellite, and the most complex and advanced earth observation satellite that ISRO has built so far". With an overall mass of 1,625 kg, CARTOSAT-3 would address increased user's demands for large-scale urban planning, rural resource and infrastructure development, coastal land use and land cover, it will "also serve military purposes".

ISRO's 2020 plans

ISRO's plans to launch around a dozen satellite missions in 2020. According to ISRO Chairman K Sivan, "They will include advanced communication satellites *Gisat* 1 and *Gisat*-12R and earth observation satellites Risat-2BR2 and Microsat (for surveillance). We are also targeting to launch *Aditya* L1 (sun) mission by mid-2020 and the first unmanned test-flight of *Gaganyaan* in December 2020." The *Aditya* L1 will be the country's first solar mission that will help scientists study the solar corona. "A PSLV will be used to carry the spacecraft, work on which is going on" The 400kg satellite, which will carry six scientific payloads, will be inserted in a halo orbit around the Lagrangian point 1 (L1), which is 1.5 million km from the Earth, having a major advantage of continuously viewing the Sun without any eclipse.

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APPOINTMENTS

All three Chiefs from same NDA Course

The Tri-Service training institution National Defence Academy at Khadakwasla, near Pune has produced many senior officers of the Indian Army, Navy and Air Force but this is for the first time that the current three Chiefs of Staff are from the same course. General Manoj Mukund Naravane, took over as Chief of the Army Staff on 31 December 2019 to join his counterparts Air Chief Marshal Rakesh Kumar Singh Bhadauria the CAS and Admiral Karambir Singh, Chief of the Naval Staff.

Coincidentally, all three wear 'wings' on their uniforms: the Air and Naval Chiefs are pilots while the Army Chief got his paratrooper wings having volunteered from his parent regiment, the Sikh Light Infantry.

General MM Naravane is Chief of the Army Staff

General Manoj Mukund Naravane took over as the Chief of the Army Staff after the retirement of General Bipin Rawat, on 31 December, 2019. General Manoj Naravane did his schooling at the Dnayana Prabodhinee Prashala, Pune, is an alumnus of the National Defence Academy and the Indian Military Academy. The General was commissioned into the 7th Battalion, Sikh Light Infantry in June 1980.

In a distinguished military career spanning almost four decades, the General has the distinction of tenating key command and staff appointments in both the North East and Jammu & Kashmir and has been part of the Indian Peace Keeping Force in Sri Lanka during 'Operation Pawan'. He commanded 2nd Battalion, Rashtriya Rifles (Sikh Light Infantry), 106 Infantry Brigade, was Inspector General Assam Rifles (North) at Kohima, Nagaland and II Corps. His staff assignments include tenures as Brigade Major of an Infantry Brigade, Assistant Adjutant & Quartermaster General (AA&QMG) of Headquarters Establishment No 22, was Defence Attache in Myanmar, had an instructional appointment in the Army War College as Directing Staff in the Higher Command Wing, besides two tenures at the Integrated Headquarters of Ministry of Defence (Army), New Delhi. After commanding the Army Training Command, Simla, he took over as the General Officer Commanding-in-Chief of Eastern Command in 1 October, 2018.

Air Marshal Vibhas Pande is AoM

Air Marshal Vibhas Pande has taken over as Air Officer-in-Charge Maintenance of Indian Air Force. Commissioned as an Aeronautical Engineer (Mechanical), he started his career as Engineering Officer in the IAF with fighters and later also gained experience in maintenance of transport aircraft and helicopters. He has flown nearly 1200 hrs on helicopters as Flight Engineer and has also been Air Force Examiner for Rotary Wing aircraft.

The Air Officer was Senior Production Engineer at No. 11 Base Repair Depot, Nasik, CO of Air Armament Inspection Wing, Khamaria, Directing Staff at College of Air Warfare and Command Engineering Officer at HQ WAC.

Air Marshal MSG Menon is AoA

Air Marshal MSG Menon has assumed charge as Air Officer-in-Charge Administration. He was commissioned in the Administrative branch of the IAF in December 1982, holds a B.Sc degree from Calicut University, has undergone Higher Air Command Course from College of Air Warfare, is an alumnus of the Defence Services Staff College Wellington and the National Defence College.

The Air Marshal is a Cat 'AYE' Air Traffic Controller and has commanded an operational radar unit at a major flying station. He has served as Commandant of the Air Force Administrative College, Coimbatore and Principal Director Ops (Air Traffic Services).

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Vice Admiral Ravneet Singh takes over as Chief of Personnel

Vice Admiral Ravneet Singh has taken over as Chief of Personnel. He is a qualified flying instructor with Master Green Instrument Rating. As a Flag Officer he has held appointments as Assistant Controller Carrier Project and Assistant Controller Warship Production and Acquisition at IHQ MoD(N), Flag Officer Goa Area/ Flag Officer Naval Aviation at Goa, Flag Officer Commanding Western Fleet at Mumbai, Chief of Staff at Headquarters Western Naval Command at Mumbai and Director General *Project Seabird* at IHQ MoD(N).

Air Marshal RJ Duckworth is SASO, WAC

Air Marshal RJ Duckworth has taken over as Senior Air Staff Officer, Western Air Command on 16 December 2019. Commissioned in the fighter stream in May 1983, he has over 3000 flight hours on various fighter and trainer aircraft and is a Qualified Flying Instructor. He has Commanded a MiG-21 squadron, was Chief Operation Officer and Station Commander of a major fighter base, Director Strategic Ops in SFC , Air-I at Eastern Air Command, Deputy Commandant College of Air Warfare and Principal Director Ops (Air Defence Weapon systems) at Air HQ.

Vice Admiral SR Sarma is Controller Warship Production & Acquisition

Vice Admiral SR Sarma took over as Controller Warship Production and Acquisition from Vice Admiral Ajay Kumar Saxena on 30 November 2019. Vice Admiral SR Sarma is an electrical engineer, had served as an electrical officer of guided missile destroyer INS *Mysore*. As Flag Officer, he has held appointments as Assistant Chief of Materiel (Information Technology & Systems) at Naval headquarters, Admiral Superintendent Dockyard at Visakhapatnam, Chief Staff Officer (Tech) at Eastern Naval Command, Director General Naval Projects at Visakhapatnam and Principal Director Advanced Technology Vessel Project at New Delhi.

As CWP&A, Admiral Sarma is the controller of acquisition of all ships and submarines under building at shipyards, both Indian and foreign. He heads the design directorates of the Navy responsible for designing ships and submarines and also the steering directorates project ships and submarines under construction.

Alok Verma takes over as Director (HR) at HAL

Mr Alok Verma took over as Director (Human Resources) of HAL on 1 January 2020, prior to which he was General Manager (HR) at the Corporate Office. A post-graduate in Labour and Social Work (LSW), he also holds the Law degree and PG diploma in computer applications, has diverse experience of over three decades in the HR function. Mr Verma was instrumental in transforming the Employee-Management relations at Hyderabad Division and recently played a key-role in settlement of the workmen wage revision.

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Lt Gen SK Saini is VCOAS

Lt Gen SK Saini has been appointed as Vice Chief of the Army Staff (VCOAS) taking charge on 25 January 2020. He was commissioned into the Jat Regiment in June 1981, commanded his battalion (7 Jat), a mountain brigade, a counter-insurgency force in J&K, a Corps in the western theatre before becoming GoC-in-C Southern Army Command in Pune.

Lt Gen Saini has also been a weapons instructor in the National Security Guard's Training Centre, senior directing staff at the National Defence College, New Delhi and Commandant of the Indian Military Academy, Dehra Dun. He had also served as the Deputy Chief Military Personnel Officer in UN Mission in Iraq, attended an exercise on peacekeeping conducted by the *Global Peace Operations* initiative in Mongolia and a counter-terrorism exercise in Australia.

The new GoC-in-C Southern Army Command is Lt Gen CP Mohanty while Lt Gen YK Joshi is likely to become GoC-in-C Northern Command following the retirement of Lt Gen Ranbir Singh.

William Blair is Vice President and Chief Executive for Lockheed Martin in India

Lockheed Martin has appointed William (Bill) Blair as Vice President and Chief Executive for Lockheed Martin in India. In this role, Mr. Blair will lead the growth and development of Lockheed Martin›s business in India and serve as the executive representative for all of the Company's programmes, products and services in the country, reports to Timothy Cahill, Senior Vice President for Lockheed Martin International. Immediately prior to assuming this post, Mr. Blair was Vice President, Strategic Solutions and Middle East Executive with Lockheed Martin›s Space Systems where he led and developed strategic solutions and expanded business opportunities in countries within the Gulf Cooperation Council, and Israel.

Ashmita Sethi is Managing Director-India, Pratt & Whitney

Pratt & Whitney, a division of United Technologies Corp. have announced appointment of Ms. Ashmita Sethi to the position of Managing Director for India. As Pratt & Whitney's senior-most in-country leader, Ms. Sethi will provide strategic direction for the Company's growth and business goals in India, and drive all of Pratt & Whitney's operations in India, including customer relations and support, the Company's Customer Training Centre in Hyderabad, Communications and Government Affairs." Ms. Sethi has more than 20 years of experience from the defense and aerospace industry and joins Pratt & Whitney following a distinguished career in corporate and public affairs, and communications with Boeing and Rolls-Royce.

Vayu shortlisted for Aerospace Media Awards Asia at Singapore

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The *Vayu* has been nominated for 'The Best Rotorcraft' submission as also 'The Best Military Aviation' submission.

Now in its 46th year of publication, the *Vayu Aerospace & Defence Review* continues to be amongst the world's leading professional journals in this discipline.

MiG-27s phased out

Flogged to the End

Seldom in history of the Indian Air Force has the phase out of an aircraft type attracted so much nation-wide publicity, especially when the type concerned hardly covered itself with glory. The IAF's MiG-27ML (*NATO : Flogger-J*) was export variant of the swing-wing tactical strike fighter from the MiG-design bureau, 165 of which were then built under licence by HAL at Nasik from 1984 and first inducted into service in January 1986. The MiG-27ML supplanted various types including the Su-7, Ajeet and latterly some MiG-23BNs, the type serving with numbers 2, 9, 18, 22 and 222 Squadrons. The MiG-27 had the dubious reputation of having the highest attrition rate in the IAF's fighter inventory.

40 MiG-27MLs were later upgraded by HAL and as the MiG-27UPG, re-equipped Nos.10 and 29 Squadrons, the last of which was phased out at this highly publicised ceremony at Jodhpur on 27 December 2019.

There were many emotional tributes paid to the MiG-27 "of Kargil fame" by some daily newspapers but the fact is that only one squadron (No.9 'Wolf Pack') took part in that conflict, based at Srinagar, one MiG-27 being lost in action. In fact, the earlier variant, MiG-23BNs of No.221 Squadron 'Valiants' were much more in evidence making their mark with concentrated bombing attacks, while Mirage 2000s of No.7 Squadron 'Battle Axes' carried out precision LGB attacks on enemy targets in the area.

Memories are short : classic aircraft with the IAF such as the Hunter, Canberra and Gnat which types actually "touched the sky with glory" during the 1965 and 1971 air wars, were phased out with hardly a whimper, sans some sentimental mess parties at their last air bases.

Photos: Simon Watson

Trapped and Launched !

The developmental LCA (Navy) Mk.I (NP-2, tail number 3002) achieved an important milestone on 11 January 2020 with the successful arrested landing on deck of the Indian Navy's aircraft carrier INS *Vikramaditya*. The aircraft was flown by the CTP, Commodore JA Maolankar of the NFTC who later carried out the maiden ski ramp take-off from the carrier the next day, 12 January 2020.

As a Technology Demonstrator, the LCA (Navy) has been repeatedly tested during extensive trials at the Shore Base Test Facility (SBTF) at INAS *Hansa,* Dabolim in Goa (*see main article 'Full Thrust Ahead'*). With completion of the critical deck landing tests, these indigenously-developed niche technologies, specific to deck based fighter operations, have been proven and will contribute towards development of a twin-engined LCA (Navy) Mk.II, which is planned for 2026 (*see article : Ahoy ! Looking at the LCA (Navy) Mk.II*).

"The landmark events of I1-12 January 2020 demonstrate the professional commitment and synergy between various agencies including ADA, HAL, CEMILAC and the Indian Navy in harnessing the potential of our scientists, engineers and naval flight testing community in meeting expectations of the nation", stated a DRDO spokesman.

'Mother ship' INS Vikramaditya seen from the LCA (Navy)

In sequence (clockwise) Seconds before touch down; View from the bridge; Tail hook about to trap; Trapped!; Taxiing on VKD's deck

Launch from INS Vikramaditya with MiG-29K positioned on side

NP-2 on ski-jump ramp

Airborne !

Heading back to INAS Hansa

Commodore Jaideep Maolankar, Group Director (FTO) & Chief Test Pilot, National Flight Test Centre (NFTC) with Aeronautical Development Agency (ADA)

Photo credits : Debadatta Maharana

"Full Thrust Ahead" !

Moving forward with the LCA (Navy)

NP1 arrested landing with max nose oleo compression

On 11-12 January 2020, the LCA (Navy) made its historic landing and take off respectively from deck of the Indian Navy's carrier INS *Vikramaditya* at sea. This was culmination of the many years of careful planning and rigorous testing of the aircraft and its systems at Bangalore and Dabolim, as detailed in this article which is based on first-hand interviews.

September 2019 was very significant, with seminal events taking place around Dabolim in Goa, shrugging off the unceasing rains during this year's monsoon, particularly this Friday the 13th which was surely an odd date for a most momentous event – the first arrested landing by an Indian-designed and developed aircraft. The trials themselves were over in a mere 15 seconds or so from the time the LCA (Navy) prototype two-seater aircraft, (NP-1), rolled out on finals at the Shore Based Test Facility at INS Hansa and 'called the ball' with 'Four Greens'.

Like all good flight test events, what followed was anti-climatic in that nothing spectacular happened : nothing broke, nothing caught fire, everything came rapidly to a halt and the pilot walked away with all ten fingers and ten toes intact.

To prove that this was no flash in the pan, the same exercise was repeated multiple times over the next few days, culminating in what was probably an even more complete demonstration of the rapid progress that this programme has made in recent months. On 29th of the same month, the other LCA(Navy) prototype, NP-2 demonstrated a complete cycle of the core essential of aircraft carrier operations by launching off the ski jump and 'trapping' at the arresting gear site.

NP2 exiting the ski jump ramp during a launch

Of course none of this happened by chance; in fact, quite to the contrary. Major achievements in aeronautics are often undertaken in a manner akin to climbing a formidable mountain. To ensure success, the ultimate achievement is broken into essential elements which are then tested and resolved in isolation. Only after all the different aspects are understood – and readiness for each has been convincingly demonstrated – is the final climb to the summit attempted. Being an absolutely pioneering effort in India, the ADA/NFTC design and testing teams have had to explore multiple hardware configurations and

software concepts in the quest for the LCA (Navy)'s configuration, making it capable of STOBAR operations.

In the current analogy, such a major mountain was the LCA's 'arrested landing', the launches off the ski ramp at Dabolim having already been demonstrated earlier. The landing exercise had to be broken into three major aspects of 'Loads', 'Handling Qualities' and 'Performance'. Underpinning all these were a series of flight test concepts, aimed at achieving safety and efficiency in this exploration venture.

Brutality of an arrested landing

The structural brutality of an arrested landing is easily visualised – but little understood. This emanates largely from the very small flight decks that can be made available for aircraft flight operations. It is ironic that while Navies spare no effort to describe their carriers in terms like 'Leviathan' and 'Colossus', only a tail hook aviator can truly understand that even the largest of aircraft carriers do not afford him the luxury of a flared landing with its highly inaccurate touchdown scatter. A significantly steeper approach angle and unflared touchdown are essential, which, coupled with the ship's pitch and heave motions, results in a typical touch down at descent rates approaching 8-900 feet per minute (fpm) and could be as extreme as 1500 fpm. To this one must add the deceleration forces generated by the arrestor hook. Even for an aircraft such as the LCA (Navy), these forces can be as high as 45 tons equivalent, radiating forward through the black and white striped shank of the hook, to be progressively absorbed by the whole structure of the aircraft and of each component attached to it.

The ability of the aircraft to withstand these forces was therefore explored by isolating the vertical and horizontal loads. Vertical loads were explored by way of un-flared touch – and – go type landings, with sink rates gradually incremented in precise steps (often as small as 50 fpm). The LCA (Navy) had been tested up to 1100 fpm as one should discount the ship's heave/pitch when operating on land.

Horizontal deceleration loads were explored by taxi-in arrestments at progressively increasing speeds. Variations in aircraft weight, engine thrust and arrestor gear settings were also conducted to clear the full envelope of expected loads up to the maximum arresting gear limit of 140 knots.

The LCA (Navy) stood up remarkably well to the loads imposed which were necessarily higher, individually, than those expected in the initial arrested landings. None of the expected problems like broken pipelines or blunt force butting of various parts was encountered. Not surprisingly however, several iterations were necessary to prepare the aircraft for a full fledged arrested landing.

Amongst the first "problems" encountered at this stage were elements pertaining to the flight test instrumentation which apparently showed higher than expected loads (until these were analysed as an artefact of the sensor locations and orientations themselves). However, dynamic responses of the aircraft to arrestment with the nose wheel raised off the deck, indicated that the nose oleo was under damped which caused nearly full stroke compression when the aircraft was de-rotated by the arrestment loads.

The hook itself needed several iterations to enable it to perform its unenviable task. These included reinforcement of the hook shank, deletion of the detachable wear plate, reduction in the trailing angle to reduce the time interval between wire pick up and main wheel touchdown - and of course at least three different variants of flight test sensor installations, not surprisingly as these were located at the exact point of origin of these smashing loads. Another major iteration was the need to provide additional room for hook swing up after it picked up the wire. Currently the LCA (Navy) is operating with a 'notch' cut into the engine bay door to accommodate this extra swing.

Probably the most important lesson learnt during this test phase was that a "conservative" design does not necessarily generate additional safety. In the case of the nose oleo, the design case was for a virtually impossible three point landing at 1400 fpm.

Close up of the complex aerodynamics at play visible in the form of the wing tip vortex and another one shedding from the inboard leading edge of the LEVCON. The aircraft has just touched down at a high sink rate as evidenced by the nose wheel forced down to touch the deck with the main wheels lifted off slightly due to a slight bounce

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Panning shot of NP1 decelerating on the runway and just beginning deployment of the tail chute

It emerged that typical landings at much lower sink rates were actually likely to be more stressful, requiring a large amount of energy to be absorbed. Notwithstanding increments to the nose oleo damping, it has, quite counter intuitively and bred a much healthier respect for avoidance of low sink rate arrestments as opposed to the slam bam of a high sink rate landing!

azimuth (to prevent excursion from the safe landing area). Achievement of the required precision is as much a matter of skill as it is of proper design of the flight control software. While much of the macho swagger of the 'tail hookers' is based on possession of these heightened piloting faculties, being skill dependent results in a wider scatter in landing parameters. This in turn forces the designers to cater for more aggravated mis-landing cases.

In case of the LCA (Navy), the advanced skills gained by ADA in digital flight controls offered a unique opportunity to attempt unraveling of this knotty problem. A unique control strategy has been implemented by the 'handling qualities brotherhood' of control systems engineers and test pilots, which results in nearly halving the workload of piloting. This has been achieved by relieving the pilot from the task of controlling speed/angle of attack and also improving behaviour of the aircraft during lateral corrections and turbulence. Results of these endeavours have been outstanding, with many landings conducted to date being within just 1-2 knots of the limit speeds of the arresting gear itself. Arrestments have been confidently conducted in fairly severe cross winds and even in extremely light surface wind conditions. The touchdown sink rate has also proven to be extremely well controlled. While the current LCA (Navy) has been designed without benefit of the enhanced accuracies achieved, future designs would surely be able to exploit these capabilities to reduce design margins and thereby achieve more efficient operational results.

The performance itself

Approach speeds are the single most critical parameter which drive the essential design of a carrier-based aircraft. Higher speeds necessarily result in higher landing loads which in turn require stronger and heavier structures to cope, which results in further increases in approach speeds thereby causing a vicious weight spiral. The key is to achieve high lift for approach while still permitting the desired optimisation at tactically relevant conditions. The LCA (Navy) has attempted to do this via the Leading Edge Vortex Controller device (LEVCON) which is deflected upwards to further destabilise the aircraft at approach speeds, controlled by drooping the elevons, effectively resulting in a more cambered, higher-lift wing profile. Several aerodynamic iterations (including different slat configurations and approach angles of attack) had to be explored to arrive at a suitable combination that yielded an acceptable approach speed.

NP2 about to arrest, having touched down with main wheels trampling the arresting cable : the hook is about to engage!

Precision handling

The other obvious constraint imposed by an aircraft carrier environment is the need for extremely precision control of the aircraft. Accuracy in achieving of the touch down point is quite obvious given limited confines of the flight deck. However the need for precision extends far beyond that. Accurate touchdowns have to be achieved while maintaining equally precise control of the speed (to control deceleration loads), slope (to control loads due to high sink rate and dynamics arising out of low sink rates and, of course, to avoid that dreaded 'ramp strike') as also lateral displacement/

At the same time precision on control had to be maintained. All these iterations, in combination with the enhanced precision of speed control, have resulted in an ability to cope with extremely low head winds encountered at the SBTF, which will certainly pay rich dividends when operating afloat owing to the much stronger winds on deck generated on an aircraft carrier.

Carrier suitability flight tests

Preparations by the crew have been achieved by a combination of two factors: deep immersion into the aircraft's design processes and infusion of knowledge from the 'best in the business' at the *Carrier Suitability Division* of the US Navy. Not surprisingly, this has been a long gestation process and is not for the faint hearted ! In fact the most experienced flight test crew in the overall LCA programme extant are those involved with the LCA(Navy). However, even greater flight test challenges lie ahead as the programme seeks to demonstrate structural soundness of the aircraft by careful demonstration of the mandated mis-landing design cases. The air crew seconded by the Navy certainly represents the most extensive and valuable of investment and affirmation of faith in this ambitious venture.

The third component of this capability has been development of a comprehensive flight testing concept allowing for rapid yet measured progression of flight tests. Recognising the unavoidable reliance on skills for the safe conduct of flight tests, all critical test cases are conducted in a systematic escalation within a single sortie.

Hot refuelling is an essential tool to avoid constant interruptions owing to lack of fuel and, more significantly, to permit repeated attempts of testing at the desired landing weights. This has led to extended sessions of up to four hours, each comprising multiple flights, rather than the typical nomenclature of sortie and flights. The only way to use this extended flight time usefully is to be able to analyse the results from the previous tests within the time employed

NP2 about to commence take off roll for ski jump launch

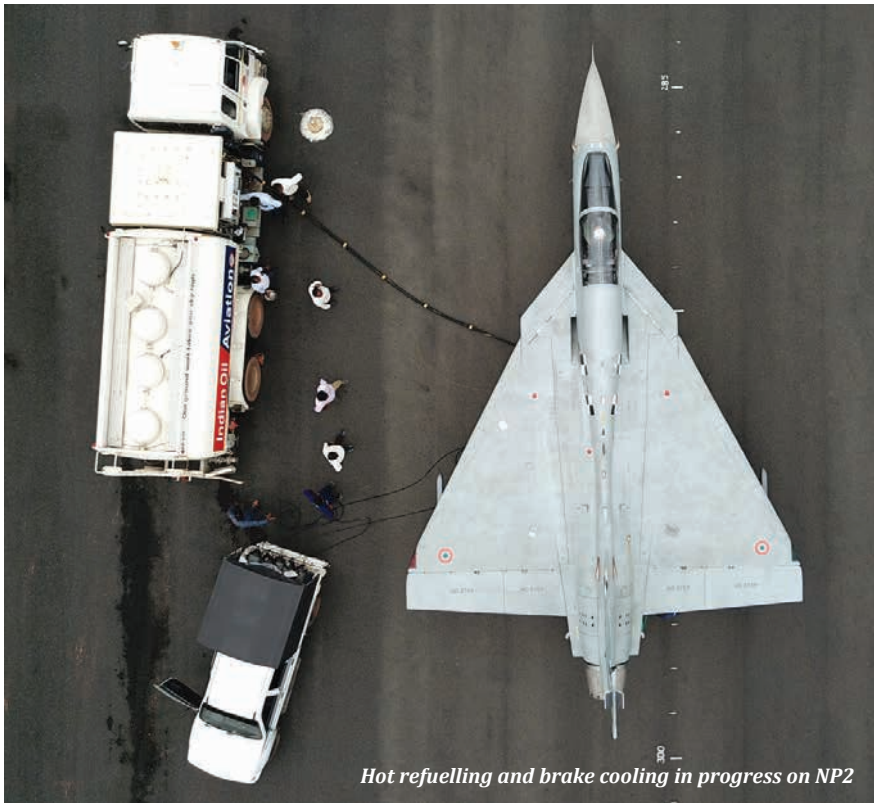
Conduct of the activities described thus far necessitated the development of an entirely new branch of flight tests for assessing the Type's carrier suitability. As in all such endeavours, achievement of safe and efficient flight testing requires a combination of investments in test facilities, test crew and a clear concept of comprehensive testing.

The most visible product of these is the Shore Based Test Facility (SBTF) which has been constructed on shore at INS *Hansa* in Dabolim, Goa. Apart from the obvious ski jump ramp and arrested landing wires, the installation includes extensive telemetry facilities for reception of data from the aircraft and instrumentation of environmental parameters. Two major additions are the deeply intrusive instrumentation of the arresting engines and the deployment of a unique photogrammetric field array using high speed video cameras. The cameras themselves may be hard to spot but the profusion of black and white chequered tracking marks on the aircraft and arresting gear site are a dead give away !

NP2 exiting the ski jump ramp

for conduct of the refuelling. A whole host of 'quick look tools' and features in the telemetry station along with major enhancements for sampling rates of many parameters have been engineered by the flight test instrumentation team. The LSO is also brought into the loop despite being situated out at the arresting gear site by extending these tools to his location, enabling him to appropriately reorient the flight test schedule for maximum efficiency and safety. By virtue of throwing a host of 'technology' at the problem, conduct of flight tests has been enabled with the minimum number of crew required.

As would be expected, there is a lot of justifiable pride associated with these achievements, most of which are uniquely 'Indian' and will naturally far outlive employment of the current test aircraft. In typical fighter pilot fashion, such *elan* has found expression in creation of two new patches : one for all the crew associated with the SBTF and the other more exclusive for those qualified to conduct 'Carrier Suitability' testing.



Hot refuelling and brake cooling in progress on NP2


Close up of Cmde JA Maolankar in the LCA-Navy cockpit

Unique patches as worn by the LCA Navy test pilots

The way ahead

So what does all of this portend for the future ? It would first be useful to take stock of what was intended and where we are now. The stated aim of becoming an aircraft carrier building nation and a three aircraft carrier navy would surely ring hollow without a matching capability to build fighters to operate from the carriers and air-launched weapons to equip them. The LCA (Navy) therefore represents one third of this reach for strategic autonomy by attempting to break into the ultra-elite club of carrier-borne fighter designers.

Reflecting on the nascent understanding of modern fighter aircraft design and carrier borne aircraft prevalent in the country, it was naively assumed that a land-based aircraft could be modified for carrier operations without too much penalty. The harsh realities of practical aircraft design guiding led to the realisation that the naval version would offer only modest operational capabilities. This was matched by a growing appreciation for the formidable mountain that we had set out to climb. Fortunately the LCA (Navy) turned out to have sufficient potential to serve as an excellent platform for exploration of STOBAR technologies and accordingly the project was re-christened

as the LCA(Navy) Mk.1 and classified as a *Technology Demonstrator*.

The current "bird in hand" has provided an excellent initiation into the rough and tumble of carrier suitability design and testing. In short time, the LCA (Navy) Mk.I has proved capable of very high intensity utilisation, yielding nearly triple the flight test productivity as compared with the overall Tejas programme.

The criticality of current endeavours to any future ambitions of credible air power afloat therefore cannot be over-emphasised as in the future, this would inevitably lead to larger and even more capable 'deck based' aeroplanes. This is true irrespective of whatever the future might require, be it unmanned, low observability or any other 'exotic' capabilities.

Apart from improvements onboard the aircraft, significant benefits are available through improving design of the aircraft carrier's launch and recovery aids. The LCA(Navy) development programme is also now undertaking design improvements to the optical landing system which would yield significant benefit to the Navy. A very major push has also been made within the programme to enhance performance of the Landing Signals Officer by the use of technology tools. Prototype tools have been implemented for approach planning, monitoring, control and debrief and are already yielding dividends in the flight test programme. When fully debugged and delivered, these could offer an immense enhancement of the Navy's capabilities afloat.

Preliminary work has commenced on automatic carrier landing systems to enhance all-weather afloat operational capability. An aircraft carrier landing poses the most stringent scenario for automatic landing by virtue of the ships inherent forward movement and oscillatory motion in response to effects of wind and waves. Efforts undertaken within the LCA (Navy) programme will be instrumental in enabling future unmanned aircraft operations as well as all-weather operations afloat and ashore.

Not to be overlooked are the immense strides made in flight testing of an aircraft for carrier suitability. The flight testing knowledge and skills being acquired as part of this programme will offer invaluable advantage when the indigenous aircraft carrier is tested for its own fitness to enter service.

The wide spectrum of benefits already flowing from the LCA (Navy) programme are clearly out of proportion with its diminutive physical dimensions. Benefits certain to accrue in the future will be invaluable in laying the foundation for India's carrier borne aviation of the future. It is really a matter of investing sufficient effort to achieve worthwhile 'payback' and spawn an aircraft carrier capability worthy of India which is reaching out to assuming 'great power status'.

Team Vayu

We acknowledge the soaring spirit and resilience of ADA and NFTC in their pioneering efforts to prepare the definitive LCA (Navy) for future carrier operations.

All images by Deb Rana

NP2 after ski jump launch, demonstrating high confidence of the crew as obvious from the adverse weather conditions in which testing operations are carried out. Contrary to common belief, strong winds are beneficial for carrier work rather than a hazard.

The team: (Back row standing) Commodore JA Maolankar
(Front row kneeling : left to right), Cdr JD Raturi, Captain Shivnath Dahiya, Cdr Ankur Jain

Admiral Arun Prakash on significance of the

All images by Deb Rana

LCA (Navy) and the IAC

The ceremonial keel laying of India's first indigenous Aircraft Carrier (IAC) by then Defence Minister AK Antony on 1 March 2009 had marked a defining moment in more ways than one. The IAC project, languishing first on the design-board and then in MoD's musty files for nearly two decades, is the largest warship ever to be built in an Indian shipyard and represents the fruition of an Indian Navy (IN) dream. Linked to this "dream-boat" is another cherished vision: that one day a *swadeshi* fighter will be launched from the deck of the IAC: India's Light Combat Aircraft (Navy).

In both these projects the IN has ploughed a lonely furrow by placing trust in the capabilities of the DRDO and PSUs. The path may be strewn with detritus from earlier unsuccessful enterprises, and many voices of "nay-sayers" are being heard, but the IN needs to remain steady on course.

A joint feasibility study of LCA ship-borne operations undertaken by a team of naval architects and test pilots revealed that a safe ski-jump launch and arrested recovery, though feasible, would be just marginal with the current ship configuration and aircraft engine thrust available. Consequently the IAC's deck length had to be increased by about 15 meters, and the redesigned ship now displaced 24,000 tons, with a corresponding increase in cost.

LCA (Navy) Mk.I (3002) landing at INAS Hansa

By 1999 the IN was seriously examining the Russian offer of their paid-off helicopter-carrier *Admiral Gorshkov* and a choice had to be made of a suitable aircraft. Discounting the venerable steam catapult, obvious options were the Su-33 (a derivative of the Su-27K) operating from the STOBAR carrier *Kuznetsov*, and the MiG-29K (see *Vayu VI/2019)*. An evaluation revealed that both aircraft would meet IN operational requirements. However, the Su-33 being a much bigger aircraft would not fit in the smaller hangar of the smaller *Gorshkov*, and would have marginal wing-tip clearances during deck launch. It was therefore decided that the MiG-29K would equip the *Gorshkov*, to be renamed *INS Vikramaditya* in Indian service.

The staff requirements having been finalised in 1999, the ADS emerged, in its definitive form, as a 37,000 ton vessel, to be powered by four LM-2500 gas turbines. The 830 foot long angled flight deck would have a set of three arrester wires, designed to handle the 24-ton MiG-29K as well as the 13-ton LCA (Navy). A set of jet blast deflectors and hydraulic chocks would be installed to provide a 600 foot deck run for launch of the MiG-29K and LCA (Navy), from the 14 degree ski-jump launch, using afterburner.

Now shedding all camouflage, the IN had re-designated the ADS as the Indigenous Aircraft Carrier or IAC.

Genesis of the LCA (Navy)

The Aeronautical Development Agency (ADA), a Society formed in 1983 by the Government of India to "fund, monitor and manage" the ambitious Light Combat Aircraft (LCA), had perhaps over-stated its capabilities by starting not only to develop the airframe and avionics, but also the engine and radar as well as digital flight controls for what was only the country's second venture into fighter development after the HF-24 Marut of the 1960s.

The programme was continuously delayed owing to several factors including US sanctions, "learning on the jet" as well as insufficient government funding. Still, the Navy boldly moved forward and began preliminary enquiries on the possibility of a ship-borne version of the LCA.

The decision to back this embryonic project was rooted in a number of reasons. The success of the first indigenously-built frigate in the 1960s had evolved into a resolve in the IN that it would be a 'builders navy' rather than a 'buyers navy', and indigenisation became an article of faith within the Service. Secondly, the IN-DRDO partnership, having delivered a few successes had, despite occasional recriminations, strengthened mutual confidence. Most significantly, the early 1990s saw design of the navy's 20,000 ton carrier (then designated as Air Defence Ship) hanging fire for many years owing to uncertainty about the type of aircraft that it would operate.

The aircraft choices available to India in the early 1990s were severely circumscribed because carrier-borne aircraft of US-origin, by far the most capable in the market, were at the time not available to India. The Russians, India's main purveyors of military hardware, had only one shipboard fighter, the three-engined VTOL fighter Yak-36 to offer. The Sea Harrier had its shortcomings, but it was still superior in most respects to the Soviet fighter.

Impact on the IAC design

For Naval Headquarters, the clinching factor stemmed clearly from contemporary geo-politics; the steam catapult used to launch aircraft from carriers was manufactured only in the USA. Since this machinery was unlikely to be available to India, the planners could discard ship designs which were based on aircraft requiring a catapult launch. This eliminated all US-origin deck aircraft as well as the French Rafale, but overtures were now emanating from Moscow, offering the derelict *Admiral Gorshkov* as a "gift", with the proviso that a Russian shipyard would re-build it to operate the Su-33 or MiG-29. This sparked off an exciting notion in NHQ: perhaps then the ADS could be designed as a STOBAR ship provided the LCA could be modified to operate in this mode ?

Enquiries about the possibility of a ship-borne version of the LCA received an enthusiastic response from ADA and a feasibility study was launched in 1995. With materilisation of the *Gorshkov* deal the IN would, for the first time, have a modern carrier with state-of-the-art fighters at sea. Although relieved of operational pressures as far as tactical airpower at sea was concerned, the Service still remained steadfast in its commitment on the LCA.

The Navy's leadership has always believed that India's claims to big power status would ring hollow as long as it remained dependent for bulk of its major weapon systems on foreign sources. In this context, success of the LCA Navy would not just put India in a select club and provide an invaluable impetus to the aerospace industry, but would also form a launch-pad for further maritime-technology ventures. The Service was well aware that the project would, not surprisingly, have its share of problems ! The Indian Navy's enthusiast support for the LCA-Navy was manifest with the letter of intent issued for 6 pre-production aircraft even as ADA began design and development of the variant.

The Navy's stake in the LCA was best summed up in the words of its visionary paper on 'Maritime Strategy': "*The ongoing aerospace projects are bold and pioneering ventures into many esoteric fields like airframe and engine design, weapon system integration, flight-control development and evolution of new materials. It is inevitable that these projects will face many hurdles, impediments and delays, but the IN will give them full support and backing. While the IN will demand quality from the DRDO, we will also extend financial and manpower support for vital projects."*

The Challenges

Highly successful carrier-borne fighters such as the US-origin F-4 Phantom, A-4 Skyhawk, F-18 Hornet and French Rafale M, originally conceived for carrier operations, were later adapted without any major problem for land-based operations, but the reverse, however, is not true and an aircraft designed to land and take-off from a 10,000 foot runway, would have to undergo critical modifications before it can operate from a ship's pitching and rolling, 800 foot flight-deck.

The Project Definition study undertaken by the Aeronautical Development Agency (ADA), with help from TsAGI, the Russian Central Aerodynamic Research Institute indicated a number of major areas which would need to be addressed before the LCA-Navy project could be declared a feasible propositions.

Essentially, the rate of descent involved in a (no flare) carrier landing, being almost twice that of a flared touch down on shore, would require a much stronger landing gear; the designed landing speed of the aircraft being too high for the ship's arrester gear to handle and the hydraulically-operated tail-hook would need to be mounted in the belly to engage the ship's arrester wires

and bring the aircraft to a stop in just 250 feet. This required the belly mounting to be strengthened to withstand the severe deceleration forces while the relatively low approach speed needed for carrier landing would necessitate this delta-winged configured aircraft to fly at high angles of attack leading to reduced forward visibility. It was thus necessary to restore visibility so that the pilot could make an accurate deck landing. With the available engine thrust, it was computed that the aircraft would attain a safe height of about 150-200 feet on exit from the ski-jump. The speed of 120-130 knots would, however, be just about marginal to retain aerodynamic control while the aircraft accelerated, and there were doubts about controllability during this transition phase.

Undaunted by the scale of technological challenges posed by these observations, the relatively inexperienced ADA/NFTC team expressed confidence that it could find ways to deal with each of the hurdles and produce a prototype LCA Navy. The Indian Navy, true to its word, re-affirmed its faith in the programme by producing a set of Naval Staff Qualitative Requirements and initiating a jointly-funded engineering development programme in 2003 with an upfront 'contribution' of over Rs 200 crores. Importantly, the Navy also seconded its few aeronautical engineers and test pilots to help manage the project.

Bringing to bear all their ingenuity and initiative, the LCA-Navy team commenced the process of 'navalising' the essentially Air Force Tejas for ship-borne operations. The first step was a new undercarriage, designed with Russian help, to withstand a vertical rate of descent of 7.5 metres/second, as opposed to 3.1 metres/second for the land-based version. A little-used aerodynamic device, known as leading-edge vortex controller or LEVCON was incorporated in the wings for improving low speed handling and reducing the landing speed. A tail hook was designed for fitment on a suitably reinforced under-belly fuselage mount. The 'drooped' nose design of the IAF trainer version was adopted for the LCA-Navy to improve over-the-nose visibility for carrier approach. Repeated computer simulations gave the team enhanced confidence that the transient post-ski-jump instability could be countered by some extra engine thrust and changes in the fly-by-wire (FBW) software.

However, two factors impacted adversely on the base-line LCA development which could well jeopardise future of the programme unless some early and resolute remedial measures were initiated. Firstly, the basic LCA having overshot its design weight, the addition of a heavier landing gear, a tail-hook and associated reinforcements aggravated the weight problem considerably in the case of LCA-Navy. Secondly, the indigenous Kaveri engine having failed to meet development milestones, the project has had to fall back on the General Electric F-404-IN-20 afterburning turbofan (which powers the IAF Tejas).

However, the F-404 barely delivered the thrust necessary to meet the IAF's performance requirements. The heavier LCA-Navy, during many phases of carrier operations, especially ski-jump launch or a late go-around on approach, would be operating at the limits of its envelope where lack of engine thrust would be a debilitating handicap. Further the air-intake design of the Tejas was optimised for high Mach-numbers and tends to 'starve' the engine of air at low speeds, which could aggravate the thrust-deficiency for a ski-jump launch. Reducing payloads to maintain safety margins would result in performance penalties, unacceptable to the Services.

LCA Navy prototype airborne

Undaunted by all the above challenges, the resolute designers and Indian Navy personnel work like Trojans and the LCA Navy prototype was ready for its maiden flight by April 2012. KHN-T-3001 (NP-1) which had been rolled out from the hangar at HAL Bangalore in mid-2010, made its maiden flight on 27 April 2012 with Chief Test Pilot of the National Flight Test Centre, Commodore JA Maolankar at the controls, carrying out a successful 20 minute flight. Still, this significant event

LCA Navy on the runway threshold

Airborne photo of NP2 with tail hook extended

evoked mixed reactions from different quarters, some sceptical as ever, posed many unanswered questions : "was there a problem with the airworthiness certificate? Why was the undercarriage left down for the flight, and where is the tail-hook ?"

However, there had been specific clearance from the Centre for Military Airworthiness and Certification (CEMILAC) and two years was not an excessive duration for ground testing of the airframe, engine and numerous systems of a prototype, much of it undertaken to satisfy the stringent criteria. The first flight of this prototype was to prove that its major systems and components, especially the computer-generated digital flight control laws, functioned effectively and harmoniously.

Led by Programme Director ADA PS Subramanyam, the design teams ensured that all systems meet the stringent requirements of carrier operations. Commodore (retd) CD Balaji, Chief Designer and Project Director LCA (Navy), had been at helm of the programme since conception, providing much-needed continuity to the development effort, while the flight control law team, led by Dr Amitabh Saraf, was responsible for ensuring that the fly-by-wire system worked flawlessly during the ski-ramp take off.

As the LCA-Navy flight-test team embarked on the unique venture of qualifying an unstable, FBW, delta-wing prototype for STOBAR operations, the programme's road map was daunting. A second prototype (NP-1) a single-seat fighter joined as technology demonstrator for undertaking ski-jump and deck-landing trials as well as weapons integration and carrier certification.

It was obvious that the undercarriage, as well as the tail-hook, were 'over-designed' and were excessively bulky, understandable as a measure of caution, but also surprising because the Russians, who provided such advice, had recent experience of designing undercarriages and hooks for their own carrier-capable aircraft types.

Although the availability of test-rigs, telemetry and a simulator in ADA took much toil and suspense out of flight-testing, there were many segments of the performance envelope which required investigation by skillful and resolute text pilots. The trials programme was first conducted ashore with two crucial parts: launch over a 14 degree ski-jump, and recovery into a set of arrester wires using the tail-hook.

The shore-based test facility (SBTF) created at the Naval Air Station Goa, at considerable expense and effort was one more manifestation of the serious IN-ADA cooperation and commitment to the LCA-


LCA (Navy) launched from the SBTF at INAS Hansa

Navy. The Russians, who pioneered the STOBAR concept, successfully undertook the daunting task of converting the shore-based Su-27K (or Su-33), MiG-29K and Su-25G, into carrier-borne versions. For testing these aircraft, and subsequently for training squadron pilots, they had created an elaborate facility at the *Nitka Centre* close to the Ukrainian port of Sevastopol, (see *Vayu Issue VI/2019)*.

The Indian SBTF, a replica of 'Nitka', is equipped with a 14 degree ski-jump located at the end of a taxi-track, on a 150 foot high cliff overlooking the sea at INS *Hansa,* Dabolim Goa. A hydraulic arrester gear, with three wires, are installed on a small stretch of parallel runway created for this purpose. The Luna optical landing aid, installed on the *Vikramaditya*, is also replicated here, the entire facility overseen by a flight-test and telemetry centre.

Although considerable data was available from many sources on arrested recovery performance, in case of the LCA-Navy, design of the tail-hook, its strength and positioning were critical factors which needed to be empirically tested. Starting with taxi engagements at increasing speeds, the trials progressed with actual arrested landings, and culminated at maximum landing weight. For instance, after the wheels roll over the arrester gear, this particular geometry does not allow sufficient time for the disturbed wires to settle down as the hook tries to engage them.

The real unexplored territory for the trials team was to be the ski-jump launch ("leap into the unknown") which required investigation of aircraft performance and behaviour in many areas. Some of these were relationship of all-up weight to deck run, engine thrust and relative wind, undercarriage oleo compression on the ramp and sudden extension on exit, controllability at ski-jump exit and acceleration thereafter. A crucial factor in this phase was accurate estimation of engine thrust available under given ambient conditions of temperature and pressure.

On 20 December 2014, NP-1 successfully launched off the ski-jump at the Shore Based Test Facility (SBTF) at INS *Hansa.* This aircraft had already made a number of flights but these were from conventional runways at Bangalore. December 2014 marked first time that the N-LCA was launched from the ski-ramp of the SBTF, which replicates the deck layout of the aircraft carrier INS *Vikramaditya* as well as the new INS *Vikrant* (IAC-1), under construction at Cochin Shipyard Limited. Piloted by Commodore Jaideep Maolankar, CTP the aircraft reportedly had "a perfect flight" performing "better than predicted". This first launch was orchestrated by the Test Director, Cdr JD Raturi and Safety Pilot Capt Shivnath Dahiya, supported by Gp Capt Anoop Kabadwal, Gp Capt RR Tyagi and Lt Cdr Vivek Pandey.

Carrier compatibility trials

On successful completion of the SBTF phase, carrier compatibility trials will represent significant challenges for the test team. Firstly, ground maneuvering (with and without engine power) in the cramped confines of the hangar and flight deck, while the ship is underway, will call for skill, forethought and planning if mishaps are to be avoided. Secondly, the aspect of ship-motion during launch and recovery will need to be approached with utmost care and prudence.

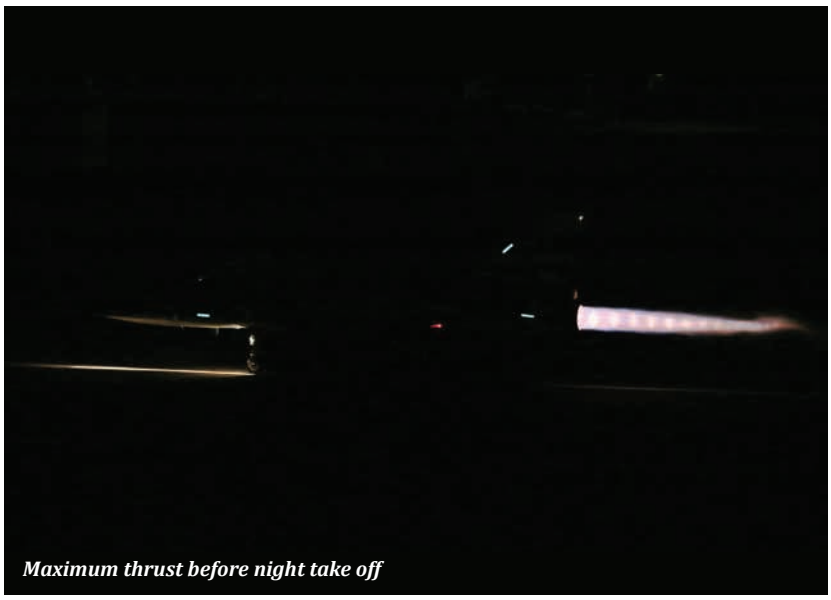
In addition to circular motion about three axes (roll, pitch and yaw), ships also tend to, unexpectedly, heave up and down in the vertical plane. Consequently the deck is either not where it was expected to be, or suddenly comes up to slam the aircraft. Often piloting skills are not enough to avoid hard impacts or over-stressing of components during shipboard operations in rough seas. Accurate recording of parameters and sensible stipulation of operating limits is called for otherwise as Cmde Maolankar puts it, "you will have either an over-designed aircraft or a broken (under-designed) one" !

LCA Navy Mk.II

Even as the Navy formalised orders for the LCA-Navy, these being 'navalised' versions of the Tejas Mk.I, with the same GE F404 engine, the well-documented weight and power issues faced by the Air Force Tejas Mk.I would be exacerbated in the challenging environment of carrier operations, and the Navy was clear that their definitive indigenous fighter would need an expanded performance envelope, longer endurance and higher payload compared to the LCA-Navy Mk.1.

The obvious solution to these limitations is more power – to be provided by the already contracted-for GE F414 engine – and weight reduction of the aircraft structure. The LCA, both land-based and naval versions, is well above target weight limits set by the respective Services, but an increase in wet thrust from the current GE F404s sub-90 kN to the F414's 98 kN would likely yield sufficient levels of performance. A simultaneous reduction in operating empty weight would certainly add to the performance provided by a new engine.

It is, of course, hoped that when the indigenously-designed, manufactured and tested LCA-Navy Mk II lands first on the INS *Vikrant* (IAC-1) and then, on the indigenously built IAC-2, it will be a significant landmark, a major reason to persevere with, and lend full support to, the LCA-Navy.



Maximum thrust before night take off

Ahoy! Looking at the LCA Navy Mk.II

Even while the LCA Navy Mk.I prototype, flown by magnificent test pilots of the NFTC, is making headlines, the inimitable designers at ADA are working on the LCA Navy Mk.II, also referred to as the twin-engine deck based fighter (TEDBF).

Some twelve years from now, a twin engine variant of the Tejas LCA fighter could well start supplementing Russian-origin MiG-29K jets deployed on board the Indian Navy's aircraft carriers INS *Vikramaditya* and *Vikrant*, the latter yet to be commissioned.

Detailed concept drawings of the fighter, dubbed the *Twin Engine Deck Based Fighter* (TEDBF), accessed by NDTV, are being studied by the Aeronautical Design Agency (ADA) and Hindustan Aeronautics Limited (HAL) which would eventually build the fighters if their development is funded by the government. In parallel, the design of an Air Force variant of the jet, the *Omni Role Combat Aircraft* (ORCA), with significant design differences, is also being studied. This variant would weigh a ton less than the Naval variant since it would not need heavy reinforced landing gear required for punishing operations from the deck of an aircraft carrier.

Sources involved with the project have indicated that the total design and development costs for developing the LCA Mk.II would be less than Rs.13,000 crores with each fighter for the Navy being in the range of Rs. 538 crores. The Indian Air Force variant of the fighter would cost between Rs 35 crore and Rs.71 crores less than the Navy variant. The development time-scale for the project has been forecast at six years from the time initial funding is provided.

Project designers say they could "very comfortably" develop the new twin engine LCA Navy Mk.II based on the experience they have gained in testing the Naval prototype of the Mk.I fighter, the prototype of which landed and took off from the deck of INS *Vikramaditya*, on 11 and 12 January 2019. The LCA Navy Mk.I is powered by a single US-origin General Electric F404-GE-IN20 turbofan engine which is however not powerful enough to justify serial manufacture of the Naval LCA in its present avatar other than in very limited numbers for further developmental testing. The significantly larger twin engine LCA Navy Mk.II now being proposed would

be fitted with two more powerful General Electric F414 engines and would have a significantly higher weapons payload and range. The additional thrust provided by two engines would also guarantee a higher safety margin for pilots while taking off and landing in hot and humid tropical weather conditions out at sea in the Arabian Sea and Bay of Bengal.

Considerably heavier, the LCA Navy Mk.II (or TEDBF) would be significantly larger than the 13.5 ton LCA Mk.1 fighter which has recently entered squadron service (in IOC configuration) with the Indian Air Force and even the 17.5 ton Tejas Mk.1A which is subject of development for the Indian Air Force. The fighter would be about size of the MiG-29K currently being operated by the Indian Navy on its aircraft carrier, the INS *Vikramaditya* and would have the ability of carrying a weapons payload of nine tonnes, and feature folding wings as per carrier aircraft norms.

Both the Navy's *Twin Engine Deck Based Fighter* and the Air Force's *Omni Role Fighter* would incorporate several indigenous sensors and avionics, some of which are now at an advanced stage of development. These include an Active Electronically Scanned Radar (AESA) which can simultaneously track targets in the air, out at sea or over land with great precision. All fighters would have indigenous data links and communication systems which would enable the fighters in a formation to securely exchange critical sensor information during missions. A host of made-in-India weapons including the Astra BVR missile which has recently been in air launched tests, would equip the aircraft.

ADA designers however refer to the fact that neither of the future variants of the LCA presently being studied are part of the Navy or Air Force's official procurement plans. However, ''more than 750 aircraft will need replacement between 2030 and 2050.'' By 2040, several older aircraft in service with the Indian Air Force, including the Sukhoi Su-30MKI, presently the largest type in numbers with the IAF, would be phasing out. Development of a larger, twin engine variant of the LCA, ADA designers feel, is an incremental step forward as they simultaneously proceed with the design and development of the fifth generation Advanced Medium Combat Aircraft (AMCA), which is both larger, more capable and more expensive than variants of the LCA. The AMCA is expected to start entering squadron service with the IAF from 2040 – all being in order.

"A twin engine variant of the LCA would be in the class of the Rafale, extremely nimble with excellent sensor fusion,'' opine designers working on plans for the future. ''This fighter would be extremely nimble with excellent sensor fusion. The fact that this would be entirely designed and developed in India would be a huge boost for our ambitions in becoming an aerospace power."

Vishnu Som

All images of the LCA Navy Mk.II are as per the artist's depiction

Growing fangs of the Tejas LCA

Developing its Potential

To enhance the operational capability of the Tejas LCA, the IAF has planned to equip it with advanced air-to-air and air-to-surface missiles. Just before Aero India 2019, the LCA received its interim FOC certification and includes some advanced features, being flight envelope expansion, improved AoA, mid-air refuelling, BVR capability, some air-to-surface weaponry, plus a more capable braking system.

Weaponry

The IAF is considering equipping the LCA with more advanced weaponry including laser guided bombs and short range cruise missiles. In February 2019, DRDO also announced that the LCA would be fitted with the new Brahmos NG, a lighter version of the Indo-Russian Brahmos supersonic cruise missile with a range of some 300km which is 50% lighter and some 3 metres shorter than the standard version.

Showcased at Aero India 2019 : LCA mockup with Brahmos-NG, AAMs and Uttam AESA

DRDO 1000 kg precision guided bomb

Apart from this, the IAF has considered some additional indigenous options, including a number of smart air-to-surface munitions such as SAAW, HSLD bomb, 1000kg guided bombs and the Sudarshan LGB, NGARM.

fighters in IAF inventory. ARDE has successfully designed and developed 250kg, 450kg, and 500kg HSLD bombs; which are effective against ground targets including railway yards, bridges, bunkers, and other hardened targets. The ARDE has contoured these weapons with two different tail units according to different mission profiles including retarder tail unit (RTU) for high-speed, low-level bombing and ballistic tail unit (BTU) for high speed, high altitude bombing. The precision-guided version of the 450 kg and 500 kg HSLD are designed for carriage by the Su-30MKI and Tejas LCA. The 450 kg PGHSLD features a nose extension unit (NEU), a smart tail unit (STU), and fixed canard on the nose to elevate and stability. The guided weapon also incorporates a semi-active laser seeker, a fibre-optic gyro (FOG) based inertial navigation system, GPS module, a GPS antenna and anti-jamming GPS antenna for guidance and anti-jamming.

The DRDO had successfully tested the 500kg PGHSLD bomb at the Pokhran test-firing range in May 2019. The inertial guided bomb is a smart version of 500 kg GPB (general-purpose bomb), the PGB developed being similar to the Israeli Spice 2000 which is in IAF service (and was reportedly employed in the strike at Balakot on 26 February 2019).

Furthermore, DRDO has developed and test-fired India's second air to surface missile NGARM, which can neutralise enemy radars 100km away, this 600 kg missile to be equipped with a PHH (passive homing head) for mid-course guidance, while a MMW active seeker will guide the missile during the end-phase. NGARM could well be one of the most potent anti-radiation missiles in world, adding further teeth to the LCA as well other existing IAF platforms.

DRDO 500 kg precision-guided HSLD bomb

DRDO labs, essentially the ADE and IRDE, are developing the next-generation Sudarshan laser-guided bomb (LGB) with improved rolling capability, accuracy and also enhanced glide-range with GPS. This new LGB will allow the LCA to hit targets more precisely at ranges of upto 50km while the NG-LGB Sudardhan is claimed to be comparable, or possibly even better than the GBU-12 Paveway which has been in service with IAF's Mirages and Jaguars for some time. The DRDO has also successfully developed an advanced Laser Designator Pod to guide laser bombs such as the Israeli-origin Spice and Sudarshan LGB.

The ARDE is in process of developing a new family of HSLD bombs that can exploit higher supersonic carrying speeds and extensive flying envelopes of various

DRDL's anti-radiation missile the NGARM

Other air-to-surface weapons which can be integrated on LCA in the future are Rudra Mk.II and ALCM Nirbhaya cruise missiles although these projects are at the initial development phase.

Besides improving the LCA's air-to-ground attack capability, the IAF is also working to enhance the type's air-to-air prowess and is in process of acquiring new CCMs and BVRs for its Tejas fleet. Currently the Russian R-73 and Rafael Derby are integrated on the LCA Mk.I and the IAF is considering the MBDA ASRAAM and possibly the Russian RVV-MD for close combat. At the planning stage is the indigenous Astra BVR, Israeli I-Derby ER and, subject to the considerable clearances, the MBDA Meteor for extended range air combat. While the ASRAAM and I-Derby ER could well get clearance, the Meteor looks rather doubtful as of now. Apart from integration of foreign AAMs, the indigenous Astra is planned to enter service with IAF's Su-30MKIs and the Tejas as well. The DRDO is also testing an SFDR (solid-fuel-ducted-ramjet) based propulsion technology for long-range surface-to-air and air-to-air missiles but this technology could still take 8-10 years to mature but could be in time for the LCA Mk.II (MWF) and AMCA.

Radar & Avionics for the Mk.IA

Apart from weaponry, the IAF and HAL are in discussion for advancing the Tejas's avionics and subsystems including integration of more capable, longer-range AESA radar, an electronic warfare suite,

ARDEs 450 kg Sudarshan LGB

an upgraded large SMFD with advanced graphics generator and high processor, a new improved canopy, satellite navigation system, advanced software upgrade for more modern systems integration, more composites, accessibility for easy and low-maintenance, as also provision for hot refueling, all these features to be incorporated in the LCA Mk.1A.

HAL has already selected Elta's EL/M 2052 AESA radar through a competitive bid, the radar to be manufactured by HAL through ToT. The fully solid-state active phased array radar will enable a longer detection range, a multi-target tracking capability of up to 64 targets, and high mission reliability; the radar also features an improved air-to-air, air-to-surface, and air-to-sea detection and operation modes with superior anti-jamming capability owing to its advanced AESA technology.

At Aero India 2019, DRDO had unveiled a model of the LCA equipped with LRDE's Uttam AESA radar. A contract for developing a new advanced EW systems worth Rs 177.43 crore has been awarded to another Israeli company (Elisra) by HAL after the indigenous unified EW system failed to fit inside the LCA airframe.

The EW systems will consist of a new-generation digital RWR, missile approach warning, a laser warning receiver, an ECM suite, state of the art CMDS and a self-protection jammer pod. This EW suite will enhance combat survivability of the LCA and besides the weapons package, such integration further enhancing capabilities of the LCA. These new weapons and avionics packages, will assuredly boost the combat plus defence capabilities of the Tejas and help to meet IAF expectations.

In IAF planning, the Tejas Mk.1A and Mk.II (MWF) are to meet its single-engine fighter requirement for upto 300 numbers and surely this will spur the DRDO to achieve success within the timeline specified. Future integration packages may also invigorate export potential of this 4+ generation indigenous fighter and enable HAL to establish itself as a major player in the global aerospace and defence market.

Atul Kumar

Transparent radome, giving clear view of the AESA radar in the LCA

Shock & Awe!

Enhanced Firepower for the Army

On 8 April 2019, the Ordnance Factories Board (OFB) handed over the first four indigenously manufactured *Dhanush* 155mm/45 calibre guns to the army. Earlier, at a function held at the field firing ranges of the School of Artillery in Deolali, on 9 November 2018, two new weapons systems and a gun towing vehicle had been formally inducted into operational service in the Regiment of Artillery. These included the 155 mm/39 calibre M777 A2 Ultra-Light Howitzer of US-origin and the K-9 Vajra self-propelled 155 mm/52 calibre gun from South Korea.

Ever since the procurement of 400 Bofors 155 mm/39 calibre FH77B howitzers in the mid-1980s from Sweden, these two guns were the first modern weapon systems to be inducted into Indian artillery and mark the end of two decades of stagnation in the army's modernisation plans. Indian Army artillery is presently largely equipped with obsolescent weapons and equipment including the 105 mm Indian Field Gun, the 122 mm howitzer, the 130 mm Catapult self-propelled gun and 120 mm heavy mortars.

As per the Indian Army's Field Artillery Rationalisation Plan (FARP) formulated in 1999, the Regiment of Artillery had obtained the Chief of the Army Staff's approval to standardise the calibre of its guns at 155 mm so as to be able to engage targets deep as inside enemy territory and to reduce the logistics trail through commonality of ammunition. The Army plans to acquire a total of 2,820 guns of all types to replace obsolescent types to equip the new regiments that will form part of the newly raised XVII Mountain Strike Corps.

Although the Government of India had contracted for licence manufacture of the Bofors 155 mm/39-calibre FH-77B Bofors howitzer in the mid-1980s, these were never produced locally as the Bofors "scam" precluded further procurement or production and eventually brought down a government.

New acquisitions have slowly begun to now move forward with the government

K-9 Vajra, self-propelled artillery gun, displayed at the formal induction at Deolali (Photo: PTI)

An M777 gun in action (Photo: PTI)

approving the acquisition of 145 pieces of 155 mm/39-calibre M777 howitzers through the Foreign Military Sales route in a government-to-government deal worth $750 million. The howitzer has a range of 24 km and weighs 4,000 kg. This weapon system, manufactured by the US-based BAE Systems, will equip seven regiments, mostly for deployment in the mountains will take a few years before all these are delivered. While the first 20 pieces are being imported, the remaining 125 will be assembled in India, possibly by a joint venture with Mahindra Defence as the Indian partner.

Meanwhile, design of the indigenously manufactured *Dhanush*, essentially based on the Bofors design, has matured into an indigenous design during its period of development. The gun has a maximum range of 38 km and an order for 114 guns has been placed with the OFB, with an option to buy 414 additional guns.

The acquisition of 814 truck-mounted self-propelled guns for semi-desert terrain has also been approved by the Defence Acquisition Council to be undertaken under the 'buy and make in India' category with the transfer of technology. While the first 100 guns will be imported, the remaining 714 will be manufactured in India. The total project cost is estimated to be around Rs 16,000 crore and Bharat Forge (partnering Elbit of Israel), Tata Power SED (Denel, South Africa) and L&T (Nexter, France) are known to be interested in this project.

Alongside, 180 numbers of 130 mm M-46 Russian-origin guns have been upgraded to 155mm/45-calibre with kits supplied by Soltam of Israel. The maximum range of the gun has increased from 27.5 to 39 km and there is an option to upgrade another 250 to 300 guns in the future as a 'buy and make in India' project.

However, the single largest artillery acquisition will be 1,580 numbers of towed 155 mm/52-calibre guns over a period of 12 to 15 years. Of these, 400 guns are to be imported and the remaining 1,180 produced in India, with transfer-of-technology mandatory. Over the last eight to 10 years, several RFPs that were floated for this project have been cancelled, allegedly because of alleged corrupt practices. New tenders were floated for these 155 mm/52-calibre long-range guns for the plains and trials are reported to have been completed. The two contenders involves joint ventures between Bharat Forge–Elbit and L&T–Nexter of France.

Meanwhile, the DRDO has embarked on its own venture to design and develop a 155 mm/52-calibre Advanced Towed Artillery Gun System (ATAGS) in partnership with Bharat Forge and Tata Power SED, both private sector companies. While Bharat Forge will manufacture the gun, Tata Power SED will provide the electronics. Efforts are also underway to mount a 130 mm gun on an Arjun MBT chassis as replacement for the Catapult,

FH-77B towed 155mm howitzers at Republic Day Parade

The Army's Catapult

which had a 130 mm gun on a Vijayanta tank chassis. 155 mm ammunition is now being manufactured indigenously, but some fuses are still being acquired from abroad.

The Russian-origin Grad BM-21 MBRL regiments, which have been in service for almost three decades, are being given extended range rockets that have a maximum range of 40 km. Progress on the multi-barrel rocket launcher front has been better than that in the acquisition of tube artillery. A contract for procurement of three regiments of the 12-tube, 300 mm Smerch multi-barrel rocket launcher (MBRL) system with 90 km range was signed with Russia's Rosoboronexport in early-2006 and Indian Army Artillery Divisions now have a regiment of this potent weapon system.

Three regiments of the indigenously-designed 214 mm Pinaka multi-barrel rocket system, manufactured jointly by Tatas and L&T, have also been inducted into service. While the Pinaka has a range of 37 km at present, the Mark 2 version of the rocket will have a range of 60 km. Both these weapon systems are un-suitable for employment in mountainous terrain.

In view of their successful employment in Afghanistan, Iraq and Syria, UCAVs armed with PGMs should also be added to the artillery's arsenal, when it be possible to achieve future military aims and objectives, including large-scale neutralisation of the adversary's war including machinery. The Army certainly requires large quantities of PGMs for the destruction of hard targets such as MBTs and bunkers and needs a potent real-time reconnaissance, surveillance and target acquisition (RSTA) capability.

Pride of the Army is the BrahMos supersonic cruise missile (Mach 2.8 to 3.0), jointly developed with Russia which has precision strike capability, very high kill energy and maximum range of 290 km. It was first inducted into the Army in July 2007 and the number of BrahMos regiments have since gone up to three. The fourth regiment will have Brahmos variant capable of 'steep dive' capability for the mountains. These terrain-hugging missiles are virtually immune to counter measures because of their high speed and very low radar cross section. After India signed the Missile Technology Control Regime, efforts have begun to increase the range to 400 to 500 km. The Government of India should seriously consider exporting the BrahMos missile system to achieve foreign policy objectives for example to Vietnam and the Philippines.

These four missile and rocket launcher weapon systems will together provide a major boost to the artillery's ability to neutralise key targets in the battlefield. However in the more strategic need is for a surface-to-surface missile with a range of 500 km to 600 km, fired from the plains to destroy targets in the Tibetan plateau which would well be critical in a future war in the mountains.

Brigadier Gurmeet Kanwal

Former Director, Centre for Land Warfare Studies (CLAWS).

BrahMos cruise missiles at Republic Day Parade

Agni Shakti*

Indigenous missiles augment Indian Army firepower

The Indian Army, after a very long period, has now embarked on its major missile modernisation programme, to supplant its existing, obsolescent missiles with indigenously developed new-generation systems that include anti-tank, air-defence, strategic land-attack cruise as well as tactical guided missiles. Some of these have already been inducted into the Army, while the DRDO is currently progressing the completion of trials for delivery of the others.

Helina ATGM (photo: MoD/Army)

Nag (Prospina) with NAMICA (photo: MoD)

New-generation anti-tank weapons

The DRDO has successfully developed a family of third-generation, subsonic and LOBL (lock-on before launch) anti-tank guided munitions to destroy the enemy's highly fortified armoured vehicles. The initial - and prime - land-attack variant of the 'Nag' missile (Prospina) has been cleared for series production after decade-long trials.

An initial batch of 293 missiles for the 13 NAMICA (Nag Missile Carrier) launch vehicles ordered will be inducted into the army, and is one of the five missile systems being developing under the Integrated Guided Missile Development Programme (IGMDP). This missile, with top-attack mode and robust high-resolution IR sights, can accurately impact enemy tanks (both static and mobile) at distances of between 500 metres to 4 kilometres in extremely hot desert conditions.

The *Helina*, which is helicopter-launched variant of the *Nag*, with a 7-8 km range, is being developed for employment by attack helicopters including the HAL *Rudra* and LCH. Several test-firings of the *Helina* to confirm accuracy, extended range and its seeker reliability have taken place but some additional testing is required to validate quality and sustainably of the weapon. An extended-range version of *Helina*, the *SANT* (Stand-Off Anti-tank Missile), with double the range, is also under development for attack helicopters and unmanned air combat vehicles of the IAF and Indian Army.

A low-weight Man Portable Anti Tank Guided Missile (MPATGM) will shortly be cleared for induction with Indian Army infantry and para-commando units, the missile now being in final phase of development. It weighs less than 15 kg and with its high-resolution IIR seeker, this DRDO-MPATGM can precisely target AFVs at ranges between 75m to 2500m.

Man Portable Anti Tank Guided Missile (photo: DRDO)

* *Fire Power*

Army Air-Defence Missile Systems

Akash Missile System (photo: Vayu)

With induction of the ramjet-powered *Akash* Mk.1 surface-to-air missile, the substitution of legacy Russian-origin systems has already begun. Alongside the *Nag*, the *Akash* is amongst the five IGMDP missile programme. The Army's *Akash* SAM battery comprises three radar systems (3D CAR, 3D Rajendra and 2D Battery Surveillance Radar) with four launchers, each having three missiles, capable of engaging multiple aerial threats at velocity of Mach 2.5 and range of 30 km, at 18,000 meters altitude. As of now, two regiments of *Akash* Mk.1s have been formed with considerable more numbers of the *Akash* entering Army Service. Meanwhile, the DRDO has recently tested a more advanced variant of the missile (*Akash*-1S) fitted with new indigenous active terminal guidance and better subsystems.

The DRDO has begun work on an extended-range (between 45-50 km) canister-launched *Akash*-NG SAM that which will have faster reaction time, better reliability, longer range and accuracy, and will integrate advanced new-gen components including a low-weight dual-pulse rocket-motor like the LR-SAM, with multi-function AESA radar and a new seeker. First test-firing of the *Akash*-NG could take place by end of the year.

Alongside, development of the 'MR-SAM' is underway this joint programme between the DRDO and Israel's IAI. This system is essentially for the Indian Air Force, but can be adapted for the Indian Army.

DRDO's Defence Research & Development Laboratories (DRDL) at Hyderabad, in conjunction with RCI, BEL and BDL are developing the mobile, compact Quick Reaction Surface to Air Defence System to replace the Army's decades-old *Osa*-AK missile systems, planned from 2021. It is credible that within thirty-months, the DRDO has completed development testing of this canisterised system.

The QR-SAM is fitted with a new-generation indigenous active RF seeker, robust ECM and mid-course inertial navigation system having with two-way data-links, and capable of search-on-the-move and track-on-the-move and firing at short halts, engaging multiple aerial threats at supersonic speed (300-500 m/s) at ranges of between 25-30 km and 30m-6000m altitude. Two 360-degree active array sensors with IFF (Battery Multi-functional Radar and Battery Surveillance Radar) and IRDE's Stabilised Electro-Optical systems empower the QR-SAM. These indigenous air-defence systems of the Army will provide robust Network Centric Warfare (NCW) capabilities, alongside the IAF's air-defence complex, within the proposed Integrated Air Defence Command an announced by Chief of Defence Staff, General Bipin Rawat.

Quick Reaction Surface to Air Missile (photo DRDO)

Cruise Missiles and Tactical Weapons

Cruise missiles are regarded as lead weapons of choice in high-intensity conflict because of their accuracy, lethally and reliability. Here, the Indian Army has a major advantage with the supersonic BrahMos cruise missile which can neutralise targets at ranges it up to 300-km with pinpoint accuracy. In recent test-firings, the Army has validated the vertical steep dive variant which is vital in mountain warfare.

BrahMos Land-based Units (photo BAPL)

Range of the BrahMos has been increased from the current 300-km to 450-km while an Indian-made X-band anti-ship seeker has been validated on the missile. In the future, a 500-km range version with boosted speed (more than the current 2.8-3 Mach) is also in development, as confirmed by BrahMos Aerospace; initial trials of the hypersonic version of Indo-Russian missile, 'BrahMos-II' would take place in the next decade.

Beyond the BrahMos, the Indian Army may soon get an additional land attack cruise missile, having significantly greater range. The Aeronautical Development Establishment (ADE) of DRDO has been working on a cost-effective, all-weather and subsonic cruise missile *Nirbhay*, with a range of over 1000-km. Developmental trials of the *Nirbhay* have already begun and next phase of testing will begin in 2020, integrating a mini-turbofan engine ('GTRE-*Manik*') with an indigenous-seeker to be validated on the missile in this phase. The 1500-kg indigenous missile is capable of operating at very low altitude (5 metres), having startlingly sharp loitering manoeuvres. The Indian Army could be the first Service to induct the *Nirbhay* even as the Indian Navy is considering a missile with 1500-km range. The Nirbhay will eventually supplement the BrahMos, in bolstering long range strike power of the Indian armed forces.

ADE's Nirbhay Cruise Missile (photo MoD)

In addition, the Army is planning more tactical weapons for massive conventional warfare. The SRBM *Pralay* which is a refined and significantly faster surface-to-surface version of the *Prithvi* with 350-400 km range, is to be test-fired shortly, this mobile and canister-stored missile capable of delivering a 1000-kg warhead at some 10m CEP.

The DRDO has also begun testing the *Prahaar*, a 420 mm lightweight, supersonic tactical ballistic missile for the Army. This 1.3 ton heavy mobile canisterised tactical weapon with 150-km range, is being developed for the Army's Strike Corps, providing cost-effective, quick reaction, with accurate firepower compared to current rocket artillery systems. The *Prahaar* mobile launcher of contains six missiles which can be fired in the salvo mode. Eventually, the combination of *Prahaar* and *Pralay* SRBMs will supplement systems like the *Shaurya* (land-variant of K-15 with hypersonic speed), these highly accurate battlefield support tactical systems becoming formidable force-multipliers for the Indian Army.

Atul Kumar

Prahaar SRBM (photo MoD)

Vikrant 'Nouvelle Génération'

Artist's depiction of the new INS Vikrant

Projected to enter operational service in 2023, the Directorate of Naval Design-designed Indigenous Aircraft Carrier-1 (IAC-1) which is to be INS *Vikrant,* represents the first aircraft carrier built in India (at Cochin shipyard) and retains the features of an Air Defence Ship (ADS) as is usually projected. The vessel was launched on 12 August 2013 and holds the distinction of being the first ship of the Indian Navy to be built entirely with domestically-produced steel in collaboration of the Defence Metallurgical Research Laboratory (DMRL) and Steel Authority of India Limited (SAIL). The ship displaces 40,000 tonnes and is powered by four General Electric LM2500+ gas turbines.

An air defence-oriented platform tasked to establish local air superiority over the oceans, the *Vikrant*'s primary air surveillance radar is reportedly the Selex RAN-40L 3D L-band search radar (based on existing land based 3D RAT-31DL) developed by Leonardo and functions as long range maritime air surveillance and early warning system *(see image)*. The radar uses a fully solid state active phased array antenna and is capable of tracking and detecting air targets, aircraft or drones up to 400 km away. Functions of the radar include Track While Scan (TWS) for air and surface long-range surveillance and missile tracking. Radar coverage is obtained by phase scanning in elevation, while mechanically rotating in azimuth. The antenna rotates at 6 rpm or 12 rpm, with 360° azimuth coverage.

Air Surveillance radar (photo from the Net)

The Barak LR-SAM on launch

MiG-29Ks of INAS 303 on board INS Vikramaditya (photo : Indian Navy)

Also prominent are Elta EL/M-2248 MF-STAR Active Electronically Scanned Array (AESA) surveillance and target acquisition radars. The ship›s combat management system (CMS) was developed by Tata Power Strategic Engineering Division in collaboration with Weapon and Electronics System Engineering Establishment and MARS, Russia.

Primary surface-to-air missile (SAM) systems are to be the Barak 8, jointly developed by Israel Aerospace Industries/ Defence Research & Development Organisation (IAI/DRDO). With its maximum range of 70 km, the Active Radar Homing (ARH) missile is highly agile throughout the flight because of the (smokeless) dual pulse rocket motor and thrust vector control (TVC). Capable of engaging multiple targets during saturation attacks, the missile is effective against multiple airborne targets at long and medium range and even can neutralise incoming supersonic Anti-Ship Missiles (AShM) at ranges as close as 500 metres, verily functioning as a point-defence system. It will be interesting to note whether the extended range 150 km Barak 8ER will be deployed on the vessel but the *Vikrant* ideally should be armed with additional "closed loop" gun/missile Close In Weapons Systems (CIWS), and these are wide options available.

Russia's Nevskoye Design Bureau designed the *Vikrant*'s aviation complex, as the Indian Navy is operating the MiG-29K/KUB as its present carrier-borne fighter. While lethality of the aircraft, enhanced by a four-channel digital Fly-By-Wire (FBW) type and the Zhuk-ME radar capable of handling multiple targets even in Look Down/Shoot Down (LD/SD) mode is beyond question, the type is plagued by serviceability and reliability issues. This is usual in almost all land-based airframes modified for carrier-borne operations. The IN is likely to welcome a dedicated twin-engine aircraft carrier-based aircraft like Dassault's Rafale M or Boeing's F/A-18E/F Super Hornet for operations from this vessel. Although the 260-plus metres long flight deck appears sufficient, the challenge will be to operate the type from the existing ski-jump ramp. In this context, it will perhaps be prudent to first develop a Naval version of the ADA Advanced Medium Combat Aircraft as the 'NAMCA', capable of aircraft carrier borne operations with appropriately strengthened airframe and arrestor hook. Its land-based variant can be developed in time with minor modifications.

The lack of a fixed wing Airborne Early Warning & Control (AEW&C) platform remains a major handicap although Kamov Ka-31 AEW helicopters have provided closer-range. INS *Vikrant* is likely to operate "under cover" of land based AEW&C support operated from mainland or offshore islands, or even integrated AEW&C cover by allied navies.

Kamov Ka-31 AEW helicopter (photo : Indian Navy)

Sayan Majumdar

The US Space Force

On 21 December 2019, US President Donald Trump officially launched the US Space Force which is regarded as America's determination to maintain dominance in Space, which he described as "the world's newest war-fighting domain". Continuing, Mr Trump said that "Amid grave threats to our national security. American superiority in space is absolutely vital… We're leading, but we're not leading by enough, but very shortly we will be leading by a lot. The Space Force will help us deter aggression and control the ultimate high ground". The US Space Force will be the sixth formal arm of the US-military after the Army, Navy, Air Force, Marines and the Coast Guard.

The Chinese have reacted by accusing the United States of turning the Cosmos into a "battlefield". The Chinese foreign ministry have called for the international community to "adopt a prudent and responsible attitude to prevent outer space from becoming a new battlefield".

US Defence Bill for $738 billion

US President Donald Trump has approved the 2020 National Defense Authorisation Act (NDAA), which will increase the US military spending by about $20 billion, or about 2.8 per cent.. The sprawling legislation has stirred up opposition overseas as it contains punitive provisions against Russia, Turkey and other countries. The Bill notes that the "(NDAA) protects European energy security by imposing sanctions related to Russian energy pipelines *Nord Stream 2* and *TurkStream*". The Bill also renewed a decision to exclude Turkey from the US-led F-35 programme in retaliation for the country's acquisition of Russia's S-400 air defence system.

US strategies for Indo-Pacific Region

The US NDAA 2020 gives a clear road map for leveraging the Indo-Pacific region "to counter Chinese expansionist moves". The US Secretary of Defence will at any given point of time have ready 'three long-term competitive strategies' to meet the Chinese challenge, for which purpose, the Pentagon will work closely with the Director of the Office of Net Assessment which provides the Secretary of Defence with comparative assessments of US military capabilities in relation to other countries as also political and regional implications. The NDAA envisages having a theatre campaign plan and widening the training of "friendly counties" in the Indo-Pacific region.

US-Pakistan military training resumed

US President Donald Trump has ordered resumption of military training for Pakistani Forces which were suspended in August 2018. This has been part of American security strategy in West Asia since the days of Cold War, and is administered under the US military command based in the Gulf region. According to observers, the US believes that Pakistan plays an essential role in the Afghan peace process and US-Taliban peace talks.

Russia deploys hypersonic nuclear missile

The Russian Government formally deployed its first formation with hypersonic nuclear capable missiles on 27 December 2019 which, President Vladimir Putin has described as, "putting his country in a class of its own". The new system, called *Avangard,* comprises a hypersonic glide vehicle which is designed to sit atop an intercontinental ballistic missile, one of several new types of weapons described by Mr Putin as "being ahead of their time". With Russia operationalising its hypersonic intercontinental missile and China also having tested a similar strategic weapon, the US Defence Secretary has said that the US too will have its hypersonic missiles "in a couple of years".

North Korea's "new strategic weapon"

North Korea's leader Kim Jong-un has said his country no longer felt bound by its self-imposed moratorium on testing nuclear weapons and long range ballistic missiles. This is the strongest indication yet that the country could soon resume such tests. Kim also said the world would witness a new strategic weapon "in the near future". In the late 1970s, North Korea

had modified a Soviet-origin *Scud-B* missile with a range of 300 kms and during 1987-1992, began developing longer-range missiles, including the *Taepodong-1* (2,500km) and *Taepodong-2* (6,700km). In October 2006, North Korea carried out the first of five underground nuclear tests and in August 2016 fired for the first time a ballistic missiles directly into Japanese controlled waters.

China's defence budget increased exponentially

Over the last 20 years, China's defense budget has grown by 850% from $20 billion to $170 billion in 2018, according to US analysts. The Chinese armed forces are now the largest in the world and the nation continues to add to its capabilities, "being increasingly provocative, such as its activities in the South China Sea and in Africa, where China established its first overseas base ever in Djibouti in 2017", according to US Defense spokesmen.

"China's ground forces themselves exceed one million personnel, a large maritime militia supplements its 300-ship navy and 250-ship coast guard, its air forces operate over 2,600 aircraft, it maintains a ballistic missile arsenal consisting of 750-1500 short range, 150-450 medium range, and 80-160 inter-mediate range variants". Chinese development of nuclear capabilities is extensive, and the PLAN intends to increase the number of operational SSBN class submarines from four to six.

China launches Ethiopia's first satellite

Ethiopia's first satellite was sent into space on 20 December 2019, a landmark achievement for the ambitious country that also caps a banner year for Africa's involvement in space. A Chinese *Long March* 4B rocket was used for this the first Ethiopian Remote Sensing Satellite (ETRSS-1), launched from the Taiyuan space base in northern China. The 70kg satellite was developed by the Chinese Academy of Space Technology alongside 21 Ethiopian scientists, and will send back data of the environment and weather patterns in the Horn of Africa - a boon for a country dependent on agriculture and forestry and vulnerable to flood, drought and other climate perils.

Reaper strike in Iraq

On 3 January 2020, General Qasem Soleimani, head of Iran's elite Quds Force and Abu Mahdi al-Muhandis, deputy commander of Iraq's PMF were killed by missiles fired from a US armed drone on the outskirts of Baghdad International Airport. This would trigger off spiraling confrontation that could spread from Iraq and engulf the wider region. "The killing of a top Iranian General is almost like a declaration of war", according to geo-political experts.

The General Atomics MQ-9 Reaper remotely piloted aircraft was developed to support US overseas operations, the 'M' indicating its multi-role, 'Q' for being a remotely piloted aircraft while '9' means it is 9th in the series of RPAS. The Reaper is used by the United States Government to target designated individuals where the US is engaged in anti-terrorist operations, be it Afghanistan, Syria and now Iraq. The MQ-9 Reaper carries a targeting systems with a suite of visual sensors and armed with four laser-guided air-to-ground Helfire missiles for highly accurate, low-collateral damage strikes.

The Grim Reaper

For thousands of years, various cultures have had figures to represent death. One of the most common and enduring of these is the Grim Reaper, who appeared in Europe during the 14th century at the time of the world's worst pandemic, and was a skeletal figure, shrouded in a dark, hooded robe and carrying a scythe to "reap" human souls.

GA-ASI to enhance Gray Eagle ER capabilities

General Atomics Aeronautical Systems, (GA-ASI) has teamed with the US Army to enhance capabilities and survivability of the MQ-1C ER Gray Eagle Extended Range (GE-ER) Unmanned Aircraft System (UAS). This involves upgradation of the Gray Eagle ER's avionics, datalinks and software in order to improve the UAS's operational capability in contested environments. The modernisation initiative provides an open architecture concept on the aircraft that is capable of hosting government-owned software, as well as increased autonomy required to support Scalable Control Interface and the rapid integration of long-range sensors.

South Korean MALE UAV

Korean Air have unveiled a prototype of its KUS-FS strategic medium altitude long-endurance (MALE) UAV required for the Republic of Korea Air Force (ROKAF). This was shown at the Seoul International Aerospace & Defense Exhibition 2019 (ADEX 2019). Two prototypes of the KUS-FS (Korean Unmanned System – Fixed-wing Strategic) have been built. The second prototype includes improved avionics and internal mission systems but is still under wraps. Development of the KUS-FS (also referred to as the MUAV) would be followed by series production and ready for Acquisition Programme Administration (DAPA) contract.

17 more F-35Bs for UK

A new tranche of Lightning IIs includes 17 F-35 aircraft for the UK, the contract having been finalised by the US Department of Defense and Lockheed Martin on 29 October. The UK will begin to receive these Lot 12 aircraft in 2020 when three aircraft are scheduled to be delivered. Lot 13 will provide six aircraft in 2021, while eight more will follow under Lot 14 in 2022

Final Typhoon for RAF

The final Eurofighter Typhoon for the RAF was delivered end-September, completing orders for the service. A ceremony was held at the company's final assembly facility at Warton to mark the milestone delivery of the Tranche 3 aircraft which is of standard FGR Mk.4.

More Airbus C295s ordered

Burkina Faso has placed a firm order for an Airbus C295 military airlifter, to reinforce its military transport capabilities. Ireland's Department of Defence has announced acquisition of two Airbus C295 medium airlifters in a maritime surveillance configuration, the Irish Air Corps being the 33rd C295 operator worldwide. The Czech Air Force has recently ordered two additional Airbus C295 medium airlifters, due to be delivered in the first half of 2021, which agreement takes the Czech Air Force's total C295 fleet to six aircraft.

Finland's HX programme

The Finnish Defence Forces have issued a revised request for quotation for their HX fighter programme. The Defence Ministry have sent the revised call for tenders to Dassault Aviation (Rafale), Eurofighter (Typhoon), Boeing (F/A-18E/F), Lockheed Martin (F-35A) and Saab (Gripen E/F) with a price cap of €10bn (US$11.15bn). Responses are to be submitted by 31 January 2020 leading to a final decision on the platform in 2021.

Russian Tu-160s on long-range deployment

In a unique deployment, Russian AF Tu-160 strategic bombers visited South Africa, the *Blackjacks* flying to the Air Force Base Waterkloof near Pretoria and were escorted in by three SAAF Hawk Mk120s and a pair of Gripens flying from AFB Makhado. The strategic bombers flew to South Africa under a bilateral military co-operation agreement signed by the respective defence ministries, the visit timed to coincide with the first Russia-Africa summit in the Black Sea city of Sochi. The bombers were supported by VKS Il-62 and An-124 which arrived earlier at Waterkloof. On 26 October, the two bombers departed Waterkloof after an official send-off, and later flew over the Indian Ocean, after refueling at Johannesburg and heading back to Russia.

Indonesia seeks F-16 Block 72 fighters

The Indonesian Air Force is looking to procure two squadrons of F-16V Block 72s as part of its next strategic plan, covering 2020 to 2024. Currently, the air arm operates 32 F-16s, 18 F-16C Block 25s, five F-16D Block 25s, seven F-16A Block 15s and two F-16B Block 15s.

Taiwan's F-16 plans

There are reported delays in the Republic of China Air Force's (ROCAF's) F-16V upgrade programme, work currently being undertaken by the Aerospace Industrial Development Corporation (AIDC), Lockheed Martin's local technical partner, at its Taichung facility. There is a backlog of 32 aircraft in various stages of upgrade. Taiwan is launch customer for the F-16V upgrade locally known as the *Phoenix Rising Programme*. The latest upgrade schedule planned to retrofit batches of 4, 24, 27, 34, 36 and 15 F-16A/Bs each year between 2018 and 2023. While the target for 2018 was met, it was revealed that only six aircraft deliveries have been made in 2019, all deliveries thus far made to the 4th Tactical Fighter Wing (TFW) at Chiayi Air Force Base. Taiwan is meanwhile pursuing the procurement of 66 additional F-16V Block 70s. The ROCAF intends to station the newly built F-16Vs at Chihhang AFB in Taitung by the mid-2020s.

Japan to upgrade F-15Js

The Japan Air Self Defense Force (JASDF) will upgrade 98 McDonnell Douglas/Mitsubishi Heavy Industries F-15J Eagle fighters to significantly enhance its air defence capability. The upgrade will include replacement of the F-15Js existing Raytheon APG-63(v)1 active electronically scanned array (AESA), with the APG-82(v)1 multi-mode AESA radar now being fitted to the US Air Force's F-15E Strike Eagles under the radar modernisation programme. Other equipment specified in the $4.5 billion deal includes Honeywell Advanced Display Core Processor II (ADCP II) mission computers, BAE Systems, ALQ-239 Digital Electronic Warfare System units and Rockwell Collins ARC-210 radios. While Boeing will be the prime contractor for the FMS portion of the work, MHI will assume the lead contractor role for the direct commercial sale elements. The JASDF currently operates around 200 Eagles, comprising single-seat F-15Js and twin-seat F-15DJs, with the majority assembled in Japan by MHI.

Advanced Hawkeyes for French Navy

The French defence ministry has plans to replace its three E-2C airborne early warning and control aircraft with a similar number of E-2Ds. An order for the Advanced Hawkeyes is expected in 2020 as is a contract for seven Falcon 2000LXS Albatros maritime surveillance aircraft to replace the Guardian and Falcon 50 used in the role.

Korea's ISTAR platform

The Raytheon Company will partner with Korean Air to develop a platform for the ROKAF's intelligence surveillance target acquisition and reconnaissance (ISTAR) aircraft programme. Under the agreement, Raytheon will provide multi-intelligence (Multi-INT) technologies for the air vehicle as prime contractor, while Korean Air will deliver design, logistics and life cycle support services for the programme. The platform will be based on Bombardier's Global 6500 business aircraft and modified for the Multi-INT ISTAR role by Raytheon and Korean Air, in partnership with the original equipment manufacturer. As per Raytheon, "Multi-INT synthesises data from a variety of sensors – including radar, multifunction electro-optical/infra-red and signals intelligence suites – to create a comprehensive picture of the battlespace."

Su-34 production moved from NAPO to KnAAPO

It is learnt that the Russian Government are considering ending military aircraft production at Novosibirsk, instead moving it to the Komsomolsk-on-Amur Aircraft Plant (KnAAPO). A 100bn rouble contract signed in 2012 for 92 Su-34s for the VKS kept the Novosibirsk Aircraft Production Association (NAPO) 'V P Chkalov' plant busy for many years, with an output of 14-16 aircraft annually. With just four more to be delivered, this will bring total NAPO Su-34 production to 134. The next order, expected to be signed in early 2020, will be for 48 examples and it is considered to be more cost effective to produce Su-34s for the new order at Sukhoi's main production site which is currently manufacturing the Su-35s and preparing for series production of the Su-57.

Although work on the previously out of production Tu-160 has been limited, a January 2018 contract for ten new-production Tu-160M2s now bringing work to Novosibirsk.

Iran's Kowsar-88 (*Yasin*) programme

Prototype of the Iran Aviation Industries Organization's (IAIO's) Kowsar-88 advanced jet trainer, has been named the *Yasin*. The prototype first flew on 15 October at the 3rd Tactical Air Base at Hamadan-Nojeh. Development of the aircraft by the IAIO's Aerospace Research Centre has been underway for many years with the prototype first unveiled at a ceremony in April 2017, at the Iranian Helicopter Support and Renewal Company's No 1 Plant

raft north of Tehran-Mehrabad International Airport. Although a new design, the *Yasin* makes much use of components stripped from retired IRIAF F-5A/Bs. The IRIAF had earlier reported that it planned to acquire 50 *Yasins* for use as advanced jet trainers as also for light attack.

Brazilian cruise missile

The Brazilian Air Force is to develop a long-range air-launched cruise missile, named MICLA-BR. An air-launched development of the MTC-300 (or AV-TM 300) surface-to-surface missile, the weapon has undergone integration tests on the central pylon of a F-5M fighter. The 300km range missile will feature inertial/GPS guidance and an image correlation system for terminal navigation.

Airbus' stealth UAV, the 'LOUT'

Airbus' has recently its concept for a stealth unmanned combat aerial vehicle demonstrator for the German Government. Model of the Low Observable UAV Tested (LOUT) was displayed during a media briefing in November, but the project remains highly secretive and very limited details were provided. LOUT development work began in 2007 at Manching near Munich and Bremen in what the company calls a "Skunk Works approach". LOUT was developed to demonstrate, "wideband signature reduction technologies and (be) a testbed for further VLO integration". The LOUT concept has a distinctive diamond-shaped planform with a configuration intended to support "radar, infrared, visual and acoustic stealth".

Airbus and the German defence ministry are also using the programme to investigate stealth technologies for future manned aircraft too and it seems certain that technologies tested in the programme could well be incorporated in the Franco-German Future Combat Air System (FCAS).

KA-1s for Senegal

Korea Aerospace Industries (KAI) have completed production of the first *Armee de l'Air Senegalaise* KA-1S Woongbi light attack aircraft. In July 2016, KAI had announced orders for four aircraft from Senegal. At the time it was stated that the order was for the

export variant of the KT-1 basic trainer, but latest reports suggest that it is the KA-1 armed advanced trainer with light attack and forward air control capabilities.

Tunisia orders T-6C Texan II

The US State Department has approved a possible Foreign Military Sale of 12 T-6C Texan IIs to Tunisia at an estimated cost of US$234m, including related spares, ground support equipment and technical support. "The aircraft will be used for training pilots and supporting Tunisia's counterterrorism and border security missions".

NC212i for KASET Thailand

PT Dirgantara Indonesia (PTDI) has delivered the first of two NC212i transports ordered by Thailand's *Krasuang Kaset Lae Sahakon* (Ministry of Agriculture and Co-operatives) for operation by its Royal Bureau of Rain Making and Agricultural Aviation, more commonly known by its local acronym, KASET. Procurement contract for the two KASET NC-212i aircraft was signed between PTDI and AICE Enterprises (Thai) Co Ltd, on behalf of MOAC in March 2017. KASET has been a long-standing operator of the C212, having flown the type since 1978. The current fleet includes four NC212-100s, one NC212-200, one NC212-400, one NC212i, five C212-300s and two C212-400s.

Meanwhile, the Nepalese Army has received CN235-220 transport from Indonesia's state-owned PT Dirgantara Indonesia (PTDI) arriving in Kathmandu on 2 November 2019.

More ATR 72MPs for *Guardia di Finanza*

Italy's *Guardia di Finanza* law enforcement agency has ordered three additional Leonardo ATR 72MP aircraft, which brings the service's order to four aircraft, following contract for an initial example that was signed in July 2018. The first aircraft was delivered of 2019 and the additional three are expected to arrive before the end of 2022. The four aircraft will be utilised by the agency for border protection, maritime surveillance and SAR missions. The

Italian Air Force already operates a maritime surveillance version of the ATR 72 airliner equipped with Leonardo's modular Airborne Tactical Observation and Surveillance mission system and known as the P-72A.

NH90 Sea Lion for Marineflieger

The first NHI NH90 Sea Lion naval multi-role helicopter has been delivered to the *German Bundesamt four Ausrüstung, Informationstechnik und Nutzung der Bundeswehr* (Equipment, information Technology and Information Support). The German *Marineflieger* had selected the NH90 Sea Lion to replace its Westland Sea King Mk.41 helicopters in March 2013 with the acquisition contract signed in June 2015. The Navy has 18 Sea Lions on order, with deliveries expected to be completed by 2022. The helicopters will be used for land-based SAR operations, maritime reconnaissance and special forces support operations and also embarked in the Bundesmarine's *Berlin*-class (Type 702) combat support ships.

More Chinooks for RAF

14 additional Boeing Chinooks for the RAF are planned. the RAF presently having 60 Chinooks (eight HC5,14 HC6 and 38 HC6A), with the acquisition of new variants to eventually replace the oldest airframes, some of which are nearly 40 years old. The new Chinooks for the RAF will be in Special Forces configuration, similar to that of the US Special Operations Command MH-47G Block II variant.

Norwegian NH90s

Last batch of NH90 NATO Frigate Helicopter (NFH) for the *Forsvaret* (Norwegian Armed Forces) have been delivered from Leonardo Helicopters facility in Tessera, Italy. Norway had ordered 14 NH90 NFHs in November 2001, including eight for search and rescue and fisheries inspection operated on behalf of the coast guard and six for anti-submarine warfare used for the navy. Norway will complete induction of the NH90s in 2022 with all helicopters fully operational by 2025. The NH90s are flown by two *Luftforsvaret*

(Royal Norwegian Air Force, RNoAF) squadrons. No.334 *Skvadron* operates NH90s from Bardufoss air base and Haakonsvern naval base in support of the navy. Also at Bardufoss, 337 *Skvadron* is tasked with support for the Coast Guard.

Mi-17V-5s for Serbia

The *Ratno* Vazduhoplovstvo i Protivvazduhoplovna Odbrana (RV i PVO, Serbian Air Force and Air Defence) took delivery of three new Mi-17V-5 helicopters in October, arriving on board a Russian An-124 transport. The Mi-17V-5s serve with the 890 *Mešovita Helikopterska Eskadrila* (890th Mixed Helicopter Squadron) in basic unarmed configuration. The three new helicopters are in combat configuration with four external hard points, ASO-2V flare dispensers and armour around the cabin and engines.

MH-139A helicopter is the 'Grey Wolf'

The US Air Force Global Strike Command has named the MH-139A helicopter as 'Grey Wolf' which is the first major acquisition for the command in its 10-year history. The name

'Grey Wolf' is derived from the wild species that roam the northern parts of North America, which also encompasses various ICBM underground silos. The USAF is to procure 84 MH-139A 'Grey Wolf' helicopters, replacing the UH-1N, which entered operational service in 1970.

Russian attack helicopters delivered

Rostec's holding company Russian Helicopters delivered over 20 attack helicopters to the Russian Defence Ministry in 2019. "This year, the forces have received Ka-52 Alligator reconnaissance and strike helicopters, transport and combat helicopters Mi-35M and combat helicopters Mi-28N and Mi-28UB. In addition, we completed the delivery of the first modern Mi-28NM Night Hunter combat helicopters and by 2027 we will produce 98 such machines for the Defense Ministry," stated Aviation Cluster Industrial Director of the Rostec State Corporation, Anatoly Serdyukov.

More Chinooks for UAE

The United Arab Emirates Air Force and Air Defence are to order ten more Boeing Chinooks. The UAEAF&AD currently operates 20 CH-47Fs, operated by Joint Aviation Command's 25 Group and based at Sas Al Nakheel, Abu Dhabi. Also in service are eight Italian-built, former Libyan CH-47Cs, upgraded to CH-47C+ standard before entering service in 2006.

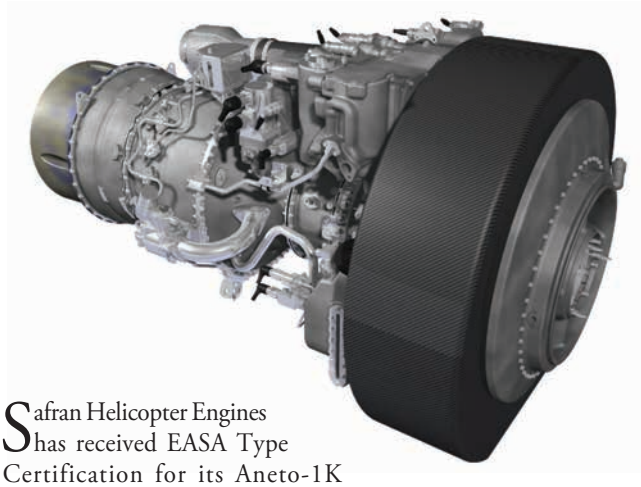
Safran's M88 training centre at Istres

Safran Aircraft Engines has inaugurated a maintenance training centre for the Rafale's M88 engines at Air Base 125 at Istres in southern France which includes latest educational tools, such as virtual and augmented reality. Safran Aircraft Engines have benefited from support of the French Air Force, the DGA's flight testing department, Istres Air Base, the Istres defense infrastructure department and Dassault Aviation, which also has a facility at the base. Meanwhile, 12 engineering personnel from the Indian Air Force began training at Safran Aircraft Engines in October 2019.

Safran and MTU partnership on NGF engine

Involved with the FCAS (Future Combat Air System) programme, Safran Aircraft Engines and MTU Aero Engines have formalised their partnership to develop an engine for the next-generation European fighter aircraft NGF. This follows the Letter Of Intent (LOI) signed between the two companies in February 2019, which specifies that Safran will take the lead in engine design and integration, while MTU Aero Engines will lead the engine services. In framework of the contractual scheme defined by France and Germany, Safran Aircraft Engines will be the prime contractor and MTU Aero Engines main partner for the first phase of Research and Technology (Phase 1A). The two partners also agreed on the foundation of a 50/50 joint venture that will be incorporated by the end of 2021 to manage the development, the production and the after-sales support activities of the new engine.

EASA certifies Safran Aneto-1K



Safran Helicopter Engines has received EASA Type Certification for its Aneto-1K engine, as fitted to the Leonardo AW189K. Intended for powering-medium and heavy weight helicopters, the Aneto family produces between 2,500 and 3,000 shp, the 1K being rated at 2,500 shp. With an 'exceptional' power-to-volume ratio, this delivers 25% more thermal power over existing similarly-rated engines, allowing for increased mission capabilities.

EASA certification for Global 5500 and 6500

Bombardier Global 5500 and 6500 business jets have received Type Certification from the European Aviation Safety Agency, the milestone following certification from Transport Canada and entry into service on 30 September 2019. Bombardier has confirmed that the G5500 is able to fly 200 nautical miles farther than planned and now has a range of 5,900 nautical miles (10,900 km) at Mach 0.85. The company said the 5,900 nautical mile range will be a standard feature of its baseline Global 5500 aircraft.

Raytheon Standard Missile-3 IIA Contract

Raytheon Missile Systems, have been awarded a sole-source, cost-plus-incentive-fee, cost-plus-fixed-fee modification under the previously awarded contract. This modification is to define the previously awarded SM-3 Block IIA fiscal 2018, contract award the fiscal 2019 SM-3 Block IIA US and FMS AURs and establish options for the FY 2020 SM-3 Block IIA US and FMS AUR production for a total value of some $ 436 million.

Raytheon's AMRAAM contract

Raytheon Missile Systems Co of Tucson, Arizona have been awarded a $768 million non-competitive fixed-price incentive (firm) contract for Advanced Medium Range Air-to-Air Missile (AMRAAM) Production Lot 33. This provides for production of AMRAAM missiles, captive air training missiles, guidance sections, AMRAAM telemetry system, spares and other production engineering support hardware.

F-35Bs onboard USS *America*

Some 13 F-35Bs took part in a routine period of training on board the US Navy's amphibious assault ship USS *America* (LHA 6) in the eastern Pacific during October. The Lightning IIs were assigned to Marine Fighter Attack Squadron 122 (VMFA-122) 'Flying Leathernecks', part of the 3rd Marine Aircraft Wing, I Marine Expeditionary Force, the largest number of F-35s ever at sea. Over a two-week period, the USMC Lightning II detachment tested sortie rates, deck cycles and multi-ship control as part of a joint US Navy-Marine Corps team.

Argentina orders four surplus P-3Cs

Argentina is to acquire four surplus US Navy P-3Cs replace the current *Comando de Aviacion Naval* (COAN, Argentine Naval Aviation Command) fleet of six P-3Bs, all of which are now grounded. The current Orions require expensive upgrades and major structural refurbishment, including main spar replacement, and it was determined that purchase of, second-hand but newer P-3Cs that have only recently been retired by the US Navy would be more economical. The P-3Cs will be operated by the COAN's former P-3B unit - the *Escuadrilla Aeronaval de Exploration,* stationed at Base *Aeronaval Almirante Zar, Trelew.*

Iran-China-Russia in joint Naval exercises

The Navies of Iran, China and Russia carried out joint exercises in the northern Arabian Sea and Gulf of Oman in late December 2019, amidst heightened tensions since the US withdrew from a 2015 nuclear deal with Iran in May 2018. According to the commander of Iran's Flotilla, "the message of this exercise is peace, friendship and lasting security through cooperation and unity... and its effect will be to show that Iran cannot be isolated". A Russian warship also participated with its visits to Chabahar port while the Chinese have called this as "the new triangle of power in the sea".

Fifth COMAC C919

The fifth COMAC C919 flight test aircraft made its first flight in late October, this latest jet from China reportedly to mainly be used for extreme weather testing in both hot-and-high and cold conditions. It will also undertake environment control, electrical power and whole-aircraft drainage tests. Even as COMAC stated that trials with four other flight test aircraft an static tests, "are in steady progress", the sixth C919 will fly by the end of 2019.

Airbus A321XLRs for United Airlines

United Airlines have ordered 50 Airbus A321XLR aircraft to replace its existing fleet of Boeing 757-200s, in a deal worth $6.5 billion. Deliveries will start in 2024 and will be employed for European services over the Atlantic from east coast hubs in Newark/ New York and Washington.

Airbus A220 progresses

Airbus celebrated the 100th A220-300 airlines produced which is destined for Latvia-based airBaltic and features a brand new cabin layout with 149 seats plus a modernised livery. The A220 Family is assembled at Mirabel and more recently, also at a second assembly line in Mobile, Alabama. Meanwhile, the Air France–KLM Group has firmed their order for 60 Airbus A220-300s to modernise its single-aisle fleet.

Flybe becomes 'Virgin Connect'

Flybe is to be rebranded as Virgin Connect in 2020, the change of identity for Europe's largest regional airline following the carrier's acquisition earlier in 2019 by Connect Airways, a consortium of Virgin Atlantic, Stobart Aviation and Cygnus Aviation. Virgin Atlantic wants to boost connectivity from the regions to its services from Heathrow. The carrier initially tried to boost passenger feed at its hub through an Airbus A320-equipped subsidiary called 'Little Red'.

Superjet 100 with Sabrelets

Sukhoi Civil Aircraft Company (SCAC) has completed flight testing of new composite Sabrelet wingtip devices developed for its Superjet 100-95B regional airliner. Russian Federation Minister for Industry and Trade Denis Manturov has stated that "the tests showed Sabrelets improve the SSJ100's take-off and landing performance and will reduce fuel burn by 4%". Sukhoi has received 295 firm orders for the type.

LCC from Abu Dhabi

Etihad Aviation Group and Air Arabia plan to launch a low-cost carrier (LCC), *Air Arabia Abu Dhabi* which will be an independent joint venture complementing Etihad's services, the new carrier to be based at Abu Dhabi. Sharjah-based Air Arabia is the largest LCC in the Middle East and North Africa. Low-cost operations are relatively under-developed in this market, with Air Arabia and Flydubai the main players in the segment.

Continuing A321XLR sales

The A321XLR continues to notch new sales successes with Vietjet signing a firm order for 20, which includes the conversion of five existing A321neo orders to the variant, while the shareholders of Hungarian low-cost carrier Wizz Air approved a provisional order for 20 examples. Czech Airlines has amended an existing order so as to receive three A321XLRs rather than baseline A321neos. IndiGo's recent 300-aircraft order for A320neo family aircraft includes an option for the carrier to place orders for the A321XLR as part of the mix. The orders further expand the backlog for the A321XLR, which has now attracted more than 250 orders (mix of firm orders and provisional deals including commitments) since its launch at the Paris Air Show in June 2019.

Debut of Boeing 737 MAX 10

Boeing has marked a key milestone with debut of the first 737 MAX 10 at the company's Renton, Washington factory. This largest variant of the MAX family, can seat up to 230 passengers and "offers the lowest seat-mile cost of any single-aisle airplane ever produced".

APKWS Laser-guided rockets for US Navy

The US Navy has signed a $2.68 billion indefinite delivery/ indefinite quantity contract with BAE Systems for the purchase of "thousands" of additional APKWS Laser-Guided Rockets, which fill the gap between unguided rockets and large precision munitions. APKWS guidance kits are compatible with new inventories of rocket motors, warheads and launchers "and easily transform unguided rockets into precision munitions with little training".

NGC Advanced Anti-Radiation Guided Missile

Northrop Grumman Corporation marked a significant milestone with delivery of its 1000th AGM-88E Advanced Anti-Radiation Guided Missile (AARGM), which is a supersonic, air-launched tactical missile system for destroying enemy air defenses. AARGM is a US Department of the Navy and Italian Air Force International Cooperative Programme.

LM's Precision Strike Missile

Lockheed Martin has tested its next-generation long-range missile designed for the US Army's Precision Strike Missile (PrSM) programme at White Sands Missile Range, New Mexico. During the flight test, the PrSM was fired from Lockheed Martin's High Mobility Artillery Rocket System (HIMARS) launcher and impacted the target which was 240 kilometers distant.

Germany orders MBDA Enforcer missiles

MBDA has been awarded by the German Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) a contract for the acquisition of Enforcer missile systems for the German Armed Forces. "The contract will fulfil the German requirement for a lightweight, day/night, precision-guided, shoulder-launched weapon system with an effective range of more than 1,800m". Enforcer provides low-collateral precision effects capabilities against threats from lightly armoured static and moving targets, targets behind cover, and against targets at long range also in urban environment. Resulting from a multinational MBDA development effort, the Enforcer will complement the 'Wirkmittel 90' shoulder-launched unguided munition capability with the German Armed Forces.

VAYU Interview with

Mrs Anandi Ramalingam,
Director (Marketing), BEL

Anandi Ramalingam-Director Marketing-BEL

VAYU : Please give us an overview of BEL's displays at DEFEXPO 2020?

Mrs Anandi Ramalingam: BEL is showcasing its state-of-the-art products and systems spanning every domain of its business – Military Communication, Radar Systems, Missile Systems, Naval Systems, C4I Systems, Electronic Warfare Systems, Avionics, Anti-Submarine Warfare Systems, Tank Electronics, Electro Optics, Gun/Weapon System Upgrades, Shelters, Unmanned Systems, Homeland Security, Cyber Security, Artificial Intelligence based systems and professional electronic components. BEL is also showing its R&D capabilities by launching/demonstrating some of its new products / technologies.

BEL's display in the area of Radar includes products/models/panels of Active Electronically Scanned Array Radar (AESA), Radar for Quick Reaction Surface-to-Air Missile, Radars for automatic detection of first-round location of artillery weapons (Weapon Locating Radar) and Border surveillance and Detection of low flying targets (like Battlefield Surveillance Radar and Air Defence Fire Control *Radar* - Atulya).

BEL's display in the area of Military Communication includes products such as Software Defined Radios, Single Box Communication Solution, Secure Versatile IP Terminal, Cyber Security products/ services, Encryptors, High Capacity Radio Relay, Data Diode used to create a physically secure one-way communication channel from one network to another, SDR VPX with NCW Applications, Configurable Live Mk II, etc.

Electronic Warfare and avionic products on display include Tethered UAV, EW Suite for Airborne Application, Quadcopter UAV, Drone Guard System, Directed Infra-Red Counter Measure (DIRCM), Combined Interrogator and Transponder (CIT), CLIFF, EOS CoMPASS, etc. as well as the complete range of Electro Optics, such as Holographic Sight, TI Sights, Image Intensifier based Passive Night Sight, Target Acquisition System, Day Night Sights for Tanks, LRF Modules, Pan & Tilt – Electro Optical Director for long range surveillance applications like coastal surveillance, border surveillance, etc.

BEL is showcasing its Naval Systems capability through Dipping Sonar, Airborne Sonar, Ship Communication Systems and Long Range Surface-to-Air Missile system.

Components/Technology modules on display include TR modules (X band and C band Quad) for Radar application, Smart cards, MPM / TWT Transmitter, Low Band receiver Modules, LTCC substrates / MMR Chips, Solar Products, Electric Batteries for two / three Wheelers, Electronic Fuses for Artillery, etc.

Other Innovative solutions and Artificial Intelligence systems on display are Face Recognition System, Social Network Analysis, Software based Record and Replay System, Video Management System, Ytterbium Fibre Laser, Power Amplifier for sonar application, LTE- Secure Mobile, Machine Intelligence & Robotic Unmanned Ground Vehicles, Radar Pulse De Interleaver, Digital Pre-distortion for Linearization of Power Amplifier,

CoMPASS on ALH Mk-IV

Electronics Target Systems, Decision Support Systems for Coastal Surveillance System, Imagery Solution, Automatic Train Supervisory System, Comprehensive Integrated Border Management System, Speech to Text Technology, Smart City Solutions, Space-based products, etc.

The highlight of BEL's outdoor display is the Weapon Locating Radar – Mountain Version, KU Band SATCOM – vehicle based; X-PAR Compact version, High Altitude Shelters, Missile Containers, Indigenous Fire Control System, Advanced Landing Ground Communication Terminal (ALG-CT) and Air Defence Tactical Control Radar (ADTCR). The entire set of state-of-art equipment on offer will be a force multiplier for any defence force.

VAYU: What are your plans to increase BEL's exports?

Mrs Anandi Ramalingam: The Government is encouraging defence exports through many policy initiatives and has set a target of Rs.35,000 crore by 2024-25. BEL has identified Exports and Offsets as one of its priority areas and has drawn up plans to offer its select products and systems to various export markets.

BEL is giving increased thrust to harnessing the export potential of its products and systems including Homeland Security solutions, Border Protection systems and state-of-the-art systems and solutions which represent its core areas of business. Having established a Coastal Surveillance System (CSS) for some neighbouring countries, BEL is interacting with the Ministry of External Affairs for supply of CSS to other "friendly countries". BEL is also exploring civil markets for Smart Cities, Solar Power Generation, etc, in third world countries.

BEL is focusing on addressing Offset obligations in various RFPs of the MoD, on account of the Offset policy incorporated in the Defence Procurement Procedure. BEL has identified contract manufacturing (build to print and build to spec) for foreign OEMs and partnerships in the form of Transfer of Technology of the latest systems and solutions as areas of emerging export opportunities. Efforts are also on to establish long term supply chain relationship with global players.

In our bid to develop new markets in the Indian Ocean Region (IOR), BEL has established overseas marketing offices in Vietnam, Sri Lanka, Oman and Myanmar.

Atulya Radar from-BEL

BEL has also expanded its Singapore and New York Regional Offices to handle marketing activities. BEL plans to work closely with Companies in other countries to increase the geo-spatial presence.

VAYU: What are the main products that you export and to which countries?

Mrs Anandi Ramalingam: BEL has been exporting products including Communication Systems, Coastal Surveillance System, Missile Systems, Radars, Electronic Warfare Systems, Electro Optic Systems and Electro Optic Fire Control Systems, Radar Finger Printing System, Naval Systems, Radar Warning Receivers, Electronic Voting Machines and various other equipment to USA, UK, Russia, Italy, Brazil, Germany, France, Israel, Indonesia, Honduras, Malaysia, Maldives, Mauritius, Myanmar, Namibia, Seychelles, South Africa and many other "friendly countries".

In 2018-19, BEL sold products and systems worth $21.6 million and had an export order book of $158 Million in late 2019.

VAYU: What about BEL's diversification initiatives?

Mrs Anandi Ramalingam: The Defence segment continues to be BEL's main business domain covering about 85% of its revenues. However, BEL is continuously exploring diversification opportunities in Defence and allied non-defence areas for enhanced growth, leveraging its strengths and capabilities acquired in the defence electronics domain.

Segments like Radars and Weapon Systems, Communication and Network Centric Systems, Tank Electronics, Gun Upgrades, Electro Optic Systems and Electronic Warfare & Avionics Systems will continue to drive the Company's growth in the coming years. As part of its diversification strategy, BEL is also continuously exploring opportunities in Defence and allied non-Defence sectors by offering spin-off technology products.

Some of the areas BEL has already diversified into are Homeland Security and Smart City, Electronic Ammunition Fuzes, Composites, Energy Storage Systems, RF Seekers, Imaging Infra-Red (IIR) Seekers, Real Time Information System for Railways, Automatic Fare Collection Gating System for Metro rail, Intelligent Traffic Management System, Satellite Integration, Cyber Security, Unmanned Systems, Composites and Solar Power Plants.

Other areas of focus include Next Generation Indigenous Surface-to-Air Missile (SAM) System, Airborne Radars, Thermal Imager Detectors for Night Vision Devices, Indian Regional Navigation Satellite System (IRNSS), Direct Energy Weapons (DEW), Helmet Mounted Display Systems (HDMS), Directed Infra-Red Counter Measure (DIRCM), IT & Cloud Services, Ring Laser Gyro, Explosives, Propellants, Smart Bombs etc, in the Defence segment, and Space Grade Solar Cells, and Air Traffic Control Radars in the non-defence segment.

BEL has signed an MoU with Tamil Nadu Industrial Explosives Limited (TEL), an undertaking of the Tamil Nadu Government, for co-operation in the explosives segment where BEL is eyeing business growth, keeping in view of its ongoing and upcoming ammunition programmes. BEL is investing for the upgradation of existing facilities and addition of new facilities, as well as setting up of a world-class centre of excellence for ammunition related technologies for both Defence and Space requirements. The strategic partnership with TEL will also boost BEL's business opportunities in the explosives segment.

VAYU Interview with

Mr Thomas Danbolt, Vice President, Large Calibre Systems, Nammo

***VAYU**: The artillery range revolution has caught everyone's imagination! Could you please share with us Nammo's 155mm portfolio and your plans for the near future?*

Thomas Danbolt: Nammo's portfolio currently consists of 155mm IM HE-ER/HE-ER (40km range) and standard HE (30km range from L52 guns). Nammo's focus is on long range artillery ammunition, from 40km range and further. Our future plans include the 155mm High Explosive Rocket Assisted Projectile, having a range of more than 70 km, with course correction fuzes as also a 100km + projectile based on Ramjet technology, both of which are in development.

***VAYU**: Can this ammunition be fired from a standard 155mm weapon, including the M777 lightweight towed howitzer currently in service with the Indian Army?*

Thomas Danbolt: Yes, the IM HE-ER/HE-ER is qualified for the K-9, PzH2000 and Archer and can be fired from all standard L39 and L52 guns currently in service, including the M777.

***VAYU**: Nammo recently showcased its ramjet-powered, guided artillery shell having a range of up to 150 km. Please give us some more information in this.*

Thomas Danbolt: Nammo is working in cooperation with The Boeing Company for development of a 155mm Ramjet projectile. Development work is ongoing and as per to schedule, test firing will be in 2020.

***VAYU**: In order to reach such distances, has there been any compromise between range and payload?*

Thomas Danbolt: For all ranges over 40km, there would be some compromise between range and payload. Since artillery is an 'area weapon', a large payload is needed to compensate for dispersion. Long ranges require guidance and this will ensure that the shells hit close to the target, what then reduces the need for a large payload. Long range rounds with guidance therefore do not need the same large payload as do unguided rounds for effectiveness.

***VAYU**: What exactly are rocket-assisted projectiles (RAP)?*

Thomas Danbolt: A rocket-assisted projectile is an artillery shell with a small rocket motor which provides some of thrust; giving acceleration after leaving the muzzle which is the opposite to normal rounds. Because of its increased velocity, the RAP round will fly higher and consequently have a longer ballistic trajectory compared with standard 155mm rounds, which in turn will provide longer range.

***VAYU**: A 70-kilometer range is, by any estimation, a substantial leap forward from the standard range of 35 kms plus. What are your plans for India?*

Thomas Danbolt: Nammo will of course offer its 70km+ round to India when this is ready for the market, within 2-3 years.

***VAYU**: What about the existing 155 gun system such as the K9, M777 or the FH 77 in service with the Indian Army: do they require modifications?*

Thomas Danbolt: Nammo's RAP round is based on our 155mm IM HE-ER, with is qualified for both K-9 and FH77, so no modifications are needed to any of these systems, including the M777.

***VAYU**: Boeing and Nammo have recently signed a teaming agreement to jointly develop and produce the next generation of extended range artillery projectiles: could you please comment on this?'*

Thomas Danbolt: The teaming is exclusively focused on developing the 155mm HE Ramjet round for the international market.

Dassault Aviation Group in 2019

During the year 2019, 26 Rafales were exported compared with 12 Rafales (9 exported plus 3 for the French Forces) in 2018. In 2019, 40 new Falcons were delivered compared with 41 in 2018 : 2019 was a difficult market.

However, in 2019, 40 new Falcons were ordered, compared with 42 the previous year. As on 31 December 2019, the backlog includes 75 Rafale (47 for export and 28 for French Forces) and 53 Falcons, compared with 101 Rafales (73 export and 28 for French Forces) and 53 Falcons as on 31 December 2018.

"To build European Defence, we need to maintain collective momentum"

Two years ago, French President Emmanuel Macron and German Chancellor Angela Merkel agreed to jointly develop the *European Future Combat Air System* (FCAS), this initiative being of major importance for European Defence which should move forward with the programme's demonstrator phase. Launching of this FCAS demonstrator phase would commence the first development phase of this 21st century European defence project. In the current geopolitical context, it ensures that Europe can maintain its industrial and operational sovereignty and meet with future threats. The objective is for FCAS to enter operational service in 2040 at the latest, which deadline might seem a long way in the future, but planning needs to start well in advance.

A Franco-German industrial organisation has been defined under the respective national leadership of Dassault Aviation and Airbus. A Franco-German Joint Concept Study (JCS) was launched in January 2019 to define the main features of the system and Spain has since officially joined the programme as the third partner nation.

Developments at Safran

Safran Helicopter engines for 'greener' vertical flight

Airbus Helicopters and Safran Helicopter Engines have teamed up "to prepare the future of cleaner, quieter and more efficient vertical flight, ahead of the upcoming Horizon Europe research programme which should be carried out during the next decade". A Letter of Intent (LoI) was signed at the Paris Air Show 2019 between the two companies which formalised their willingness to jointly demonstrate future technologies that will significantly contribute to the reduction of CO_2 emissions and sound levels for future vertical take-off and landing (VTOL) platforms. A number of technological streams will be investigated, including various levels of electrification, higher-efficiency gas turbines or alternative fuels, as well as advanced engine architectures to further reduce the acoustic footprint of turbines.

As Franck Saudo, Safran Helicopter Engines CEO, said: "This future cooperation with Airbus in the frame of the Horizon Europe programme is a great opportunity to prepare propulsion systems for future helicopters. Today, Safran is the most capable provider of integrated and efficient propulsive systems, with the widest gas turbine power range and a complete range of electric systems for hybrid electric propulsive solutions, in addition to strong testing, qualification and certification expertise. We are very pleased to partner with Airbus Helicopters in this journey for a lower environmental footprint of air transport."

CFM in agreement with China

In conjunction with French President Emmanuel Macron's state visit to China, Guizhou Airlines has finalised a 12-year Rate-Per-Flight-Hour (RPFH) Agreement for the LEAP-1A engines that will power the airline's future fleet of up to 35 Airbus A320neo aircraft, along with five spare engines. The agreement is valued at some $1.0 billion. RPFH agreements are part of CFM's portfolio of flexible aftermarket support offerings. Under the terms of the agreement, CFM Services guarantees maintenance costs for the LEAP-1A engines on a dollar per engine flight hour basis.

CFM and the LEAP engine

CFM International's advanced LEAP engine continues to set a new industry standard for fuel efficiency and asset utilisation as the fleet continues the most rapid buildup in commercial aviation history, with the fleet logging nearly five million engine flight hours through to mid-2019, less than three years after commencing commercial service. The first LEAP-powered commercial flight happened in August 2016 on a Pegasus Airlines flight from Istanbul to Antalya. Since then, more than 825 LEAP-1A and LEAP-1B-powered aircraft have been delivered to 104 operators on five continents. "The LEAP engine just keeps delivering. The rate at which the fleet has been accumulating hours and cycles is unprecedented in the industry, but it is also achieving this with better fuel efficiency, lower noise and emissions, higher reliability, and industry-leading utilization level of 96 percent of available days flown", stated Gaël Méheust, President and CEO of CFM International.

Arrius engines mark 10 million FH

Safran has marked major achievement for its Arrius engine range: 10 million flight hours flown since its introduction in 1996. With more than 3,800 units delivered to 430 operations in 60 countries, the Arrius family covers a power range of 450-750 shp and flies in both single and twin-engine light helicopters. Over the years, the Arrius range has maintained its status as the "most competitive and robust engine solution for the light helicopter market", and it continues to be selected for new models. First installed in the EC135 in 1996, the latest Arrius 2B2Plus variant entered service on the Airbus H135 in 2014.

Another variant, the Arrius 2G1, powers the Russian Helicopters Ka-226T, is in service in Russia, and part of a major military contract currently under negotiation between Russia and India. These latest models make the Arrius range as competitive as ever, and it will remain at the forefront of Safran propulsion offer for the next 20 years.

MBDA at DefExpo 2020: "Making in India"

Sea Ceptor

Loïc Piedevache, India Country Head, MBDA, said that "MBDA has two exciting focuses during Defexpo 2020: providing the highest performing missile technologies to India, and secondly delivering on *Make in India* as part of our longstanding partnership strategy with India".

Defexpo 2020 is timely as it takes place just before arrival in India of the first Rafale fighter aircraft for the Indian Air Force, which brings a truly game changing range of weapons from MBDA most notably the SCALP deep strike missile and the Meteor air-to-air missile. These are the highest performing missiles of their type available anywhere in the world, providing India the ability to strike deep at enemy targets and to totally dominate in air combat.

MBDA has been actively working in partnership with India to build up the country's defence industrial capabilities now for over 50 years. Over this period, many tens of thousands of MBDA- designed missiles have been built in India and we continue to deepen and deliver on new programmes.

For example, there is extensive manufacturing by Indian industry of 15 major subassemblies of the MICA missile that arms both the IAF's Mirage 2000 and the shortly arriving Rafale. Impressively these subassemblies cover a wide range of complex technologies such as hi-specification mechanical, electrical, electromechanical and pyrotechnic items. Similar transfers to build India's defence-industrial capabilities have also occurred on the Mistral and ASRAAM missiles, including ToT for setting up industrial capabilities for missile final assembly and integration testing.

"The highlight of our focus to provide the best missile technologies to India and deliver on '*Make in India*' is the news that L&T MBDA Missile Systems have submitted their first bid to the Indian Armed Forces; the JV's offer of Sea Ceptor, latest generation of naval air defence system, in response to the Indian Navy's Short-Range Surface to Air Missile (SRSAM) requirement, and offered with the aim to '*Make in India*'. When you consider L&T MBDA Missile Systems just made its debut at the previous edition of Defexpo, one can note the strength of our commitment and the level of investment made by MBDA to mature this joint venture at rapid pace. We will make further exciting announcements on the rapid development of L&T MBDA Missile Systems Ltd later this year.

Together, MBDA and L&T MBDA Missile Systems Ltd are presenting a comprehensive portfolio of many other high performance missile technologies at Defexpo 2020, however there are there particular systems to be highlighted: ATGM5, Exocet MM40 B3, and Mistral ATAM".

Drawing upon next generation technologies of the MMP battlefield anti-tank weapon as advanced successor to the highly successful Milan, the ATGM5 will be designed and manufactured in India to meet India's specific operational requirements. It will be a true Indian designed, developed and manufactured (IDDM) product, involving the transfer of next generation key technologies to India, and boosting the Indian defence industry sector.

The Exocet MM40 Block 3 is latest version of the well-known Exocet anti-ship missile family, with extended range of 200 km. The Indian Navy already operates the Exocet SM 39 from its submarines and would benefit from employs Exocet in other operational areas.

The Mistral ATAM air-to-air missile launcher has been delivered to India to equip both the ALH and LCH. Mistral has proven itself a major success story with a 96% success rate in all firings. At Defexpo 2020, MBDA will exhibit this very high-performing missile also as a man portable air defence system (MANPADS), which has performed "exceptionally well in India's firing trials".

MBDA starts series production of the MMP land combat missile

"IAI's long relationship with India"

VAYU Interview with Mr Nimrod Sheffer, President and CEO, Israel Aerospace Industries (IAI)

VAYU: Kindly enumerate on IAI's presence in India and its partnership with the Indian Defence forces and Public Sector Companies involved in defence production?

Nimrod Sheffer: IAI has a long-standing relationship with India and been one of the main pillars in supplying strategic and advanced equipment to the country, including cutting-edge technology for defence, aerospace and homeland security. IAI's systems, such as unmanned aerial systems (UAS), radars, special-mission aircraft, and air-defence systems, have been in operation in India for many years with a very high level of satisfaction from the Services.

We are expecting to expand our collaborations with local leading companies, both public and private, so as to integrate strategic state-of-the-art systems for India's Ministry of Defence in various fields, and in accordance with the *Make in India* policy.

VAYU: Please elaborate on IAI's UAV family.

Nimrod Sheffer: IAI is a global leader in the design, development, and manufacture of UAVs. The Heron family, with over 40 years' of experience and more than 1,800,000 operational flight hours have performing intelligence gathering and targeting missions in support of key military operations around the world, Our UAVs & loitering munitions systems are combat proven with more than 20 operators worldwide. IAI will continue to support its existing customers worldwide, while introducing additional state of the arts sensors and technologies.

VAYU: Please update us on IAI's joint venture with the DRDO with respect to the MR-SAM LR-SAM. When will the first missile systems be ready for induction?

Nimrod Sheffer: We are very proud of our work over several years on co-development projects concerning for the MRSAM Air & Missile Defense System along with DRDO. IAI has established relationships in India for more than 25 years, and the MRSAM joint development is one of the main and strategic projects of IAI in India, utilising many years of operational experience. The MRSAM is an advanced air and missile defence system that provides ultimate protection against a variety of airborne threats, in both land and naval scenarios. It was designed jointly with the DRDO in India and is in service with both the Israeli and Indian Defence Forces.

The system includes an advanced Phased Array digital radar, command and control system, vertical launchers and missiles guided by a highly-advanced seeker. The MRSAM, both its naval and land versions, is one of the most successful Israeli defense industry developments in the world. Evolution of the system is reflected in the innovation, creativity and remarkable personal dedication of all those involved in the programme. We are constantly working with our partners in India to create the best operational outcome for requirements of the Indian Army, Navy and Air Force. The MRSAM programme is progressing as planned, and IAI recently conducted a successful demonstration with our partners at the DRDO and the Indian Navy.

VAYU: What is IAI's theme at Defexpo 2020?

Nimrod Sheffer: At DefExpo 2020, IAI is presenting some of the latest and most advanced defence solutions, featuring the latest technologies in military aviation, air defence and missiles, unmanned systems, special mission aircraft, radars, as also in cyber technology.

Amongst the systems on display are the operationally-proven MRSAM, special mission aircraft, the Heron TP, the largest platform in IAI's family of advanced unmanned aerial systems (UAS), satellites, radars – both strategic and tactical – loitering munitions systems, EO surveillance systems, advanced mission systems for helicopters and much more !

IAI's 5th Generation UAS multi-Layered Mission Control Station

iUCS

IAI is fielding the 5th generation of its UAS control station. The iUCS is a game changing new 4D Innovative Unified Control System (iUCS) is the latest in UAS control, build-to-meet the multi-sensor, high-definition, multi-layered complex missions challenge designed to fly the Heron family. It brings refreshing and patent protected automation, planning, control, simulation, ergonomic and modular design to support multi-tasking easily performed mission by a single operator.

The challenges in 2020s missions have extremely increased with the development of new technologies (High-definition EO/IR/ LD, SAR, MPR, GMTI, ESM, COMMINT, ELINT, etc), bringing new demands to link to external C^2 and C^4 networking while using more and more unmanned solutions.

The iUCS is part of a solution that offers a powerful machine with maximum automation, advanced tools for mission editing and planning, automated flight, remote automated taxi, take-off and landing and latest mission operational tools. It provides synergy for the information gathered from all sources combined for better battle field situational picture and decision making.

The iUCS and Heron family provides a whole new level of complex missions handling such as: ISTAR, maritime patrol, aerial persistence, border patrol, HLS, disaster relief, time critical situations and many more.

iUCS reflects extensive investment in ergonomics and man-machine engineering, based on the extensive experience gained through over 40 years of UAS operations in more than 50 world-wide customers and over 1.7M flight hours, continuous evolution addressing user requirements and operational experience. Utilising a compact, modular design iUCS is operable as a stand-alone unit in a vehicle, or with multiple consoles grouped in a mobile (land or sea) shelter or fixed location.

iUCS can also operate in large groups, supporting multi-UAS operations centers (MOIC - Mission Operation and Intelligence Centre).

iUCS panoramic multi-screen view comprises two 32"/24" (space depended) high-resolution display screens locating the operator in the centre, providing ample viewing area for simultaneous mission planning and control, with simultaneous live sensor feeds and access to local or remote information sources accessed online.

The iUCS operation implements a fighter pilot 'Hands on Stick and Throttle' concept, patent protected, for a user centric operation, using the joystick and the touch screen to maintain directional control of the payload. An ergonomic 'throttle' type multiple controls module is operated by the one hand, controlling various aircraft systems and payload functionality. A retractable tablet-shaped touch-sensitive display provides the main interface for mission planning and control, location pointing and system interface, enabling the controller to input changes in the flight plan, employ procedures, route management, altitude changes, communications control, etc.

Special attention was given to reducing operator workload under routine operation and in emergency. Voice commands are part of the user-machine interface, as the system understands spoken instructions, repeating the command and requests user approval before carrying out the command. Handling alerts is another way for the system reducing workload. Audio warning are triggered in addition to visual alerts when required. Weather warning, limitations crossing or when approaching restricted areas, are indicated visually and verbally, drawing the operator attention to the problem by double checking appropriate action.

The entire system uses Commercial off the Shelf (COTS) hardware, and implements an open and modular architecture that allows both hardware and software to be portable, scalable, and upgradeable. Supporting international standard including all relevant NATO standards including STANAG 4545, 4586, 4607, 4609, 4668, 4669, 4671 and 7023. The system operates with multiple servers, dual redundant database and RAID storage for redundancy.

Rafael's SPYDER ADS Family

Short to Long Range Mobile Air Defence Systems

Spyder (Surface-to-Air Python & Derby Air Defence System) is a quick reaction, mobile surface-to-air missile system to counter attacks by aircraft, helicopters UAVs and precision guided munitions. The system provides effective protection of valuable assets, as well as first-class defence for maneuvering forces in the combat area. The system is capable of search-on- the-move fire within short halt.

Spyder incorporates Rafael's most advanced air-to-air missiles - the I-Derby active radar (RF) missile and Python-5, a dual waveband Imaging Infra Red (IIR) missile. The Spyder family includes Spyder-SR (Short Range), Spyder ER (Extended Range), Spyder-MR (Medium Range) and Spyder LR (Long Range) systems.

Python 5 and Derby are in service in the IAF as part of the Spyder LLQRM programme and as air-to-air missiles on the LCA. These missiles and their advanced versions will be part of future air-to-air and air defence programmes in the Indian Air Force and the Army. Both missiles can potentially be integrated on LCA, Hawk, Su-30 or any other combat aircraft in the IAF.

The truck-mounted Command and Control Unit (CCU) comprises surveillance radar with advanced ECCM capabilities that can simultaneously track multiple targets. Wireless data link communication enables deployment of the MFUs at a distance from the CCU. The CCU can operate with neighbouring Spyder air defence batteries and share information with higher echelons. This interoperability provides the SPYDER air defence system with high flexibility in combat situations. The CCU is capable of search-on-the-move fire within short halt.

Spyder's highly modular structure also allows easy adaptation to customer platforms and future growth. Its truck-mounted Missile Firing Units (MFU) are equipped with both IIR and RF missiles. The MFU carries any combination (IIR/RF) of missiles on a launcher assembly. SPYDER has 360° day/night all-weather engagement capability. The system can also engage multiple threats simultaneously. It has Lock-On-Before Launch (LOBL) and Lock-On-After Launch (LOAL) modes of operation.

With a shared operational approach and technologies, a mix of Spyder Family elements can be deployed together for significant advantages such as SR/MR launchers, embedded Radar / External radar.

SPYDER-SR/ER

Spyder-SR provides all-weather, network-centric, self-propelled, multi-launch, short-range air defence. The system enables 360° missile launching within less than five seconds of the target being declared hostile by the system. Spyder-SR features Rafael's advanced air-to-air missiles - the Derby Active Radar missile and Python-5, a sophisticated dual-waveband Imaging Infra Red (IIR) missile.

Spyder ER - using the same launching system with advanced version of RF Missile, Derby MK III, the system more than doubles the range and altitude.

SPYDER-MR/LR

Spyder-MR Medium Range Air Defence Missile System (MRADMS) shares Spyder-SR's technology. Spyder-MR engages and destroys the same wide spectrum of threats at medium ranges. It protects high-value assets (capital areas, air force bases, etc.) as well as maneuvering combat forces.

Spyder-MR provides all-weather, network-centric, self-propelled, multi-launch, quick-reaction ADS capability. Spyder-MR enables 360°missile launching within seconds of the target being declared hostile by the system. The system features the proven-performance air-to-air missiles - the Derby Active Radar missile and Python-5, a sophisticated dual-waveband Imaging Infra Red (IIR) missile. Both missiles are equipped with a booster.

SPYDER LR uses the same launching system with advanced version of RF Missile, Derby MK III with a booster, the system significantly increases the range and the altitude.

Rafael is also proud to announce that a substantial share of its air defence portfolio is now made in India. Its joint venture company, Kalyani Rafael Advanced Systems (KRAS) is displaying the air defence capability at its stall at Defexpo 2020.

Aeronautics and its Orbiter 4 UAV

Continuing evolution of the Orbiter line and the Small Tactical UAS, Aeronautics have introduced the Orbiter 4 STUAS, an advanced multi-mission platform with extraordinary and versatile carrier, mission and endurance capabilities.

"Orbiter 4 STUAS delivers top mission performance with its lightest, most versatile and most advanced covert platform available today, for both land and maritime operations". The UAV can simultaneously carry multiple payloads, extending its ISTAR capabilities. With its ease-of-use, low logistical footprint and small crew of 3 personnel, Orbiter 4, the runway-free aircraft suits all operational needs.

Orbiter 4 builds on the successful system design of the Orbiter 3 STUAS, with its advanced avionics, communications and ground control features and applications. The acclaimed legacy capabilities of the field-proven Orbiter UAS family remain. Measure for measure, Orbiter 4 will deliver the same capabilities as the tactical platforms operational today, but with better endurance, serviceability, operational flexibility and cost-effectiveness.

Recently, the Orbiter 4 unmanned aerial system has carried out a record-breaking 25 hour flight, setting a new endurance record for the company's flagship platform. "The flight was performed at mission altitude carrying the T-stamp EO payload with laser capabilities".

Manufactured by the Israeli drone company Aeronautics, the Orbiter 4 unmanned aerial system is the company's most advanced tactical UAS, the compact, light-weight system being used by military and homeland security officials with an operating range of up to 150 km. The multi-mission UAS is a versatile and light platform and, with the capability to stay in the air for 25 hours, it extends its intelligence, surveillance, target acquisition and reconnaissance (ISTAR) missions.

According to the company, the UAS has six different autonomous flight modes and can be used for artillery fire management and bomb damage assessment (BDA), target acquisition for precision-guided weapons, communications intelligence (COMINT), electronic intelligence (ELINT) and electronic warfare (EW).

Operated by a team of three, the runway-free aircraft is highly portable and easily deployable, suiting all operational needs. With a low silhouette and silent flight mode, the advanced covert platform is available for both land and maritime operations and can be used in all weather conditions.

The platform can carry – and operate – two different payloads simultaneously, integrating an electro-optical payload with laser designator, SAR radar, MPR maritime radar or other advance payloads. In addition, the system has an open architecture that allows quick integration of new advanced sensors.

"This new achievement highlights our technological leadership in the tactical UAS segment," stated Amos Matan, chief executive officer for Aeronautics Group. "The Orbiter 4 is a breakthrough system with an impressive roadmap, based on Rafael advance technology and payloads. We are committed to continue investing in developing the platform for the benefit of our customers and users, reaching more records and maintaining excellence."

"Cutting Edge Systems"

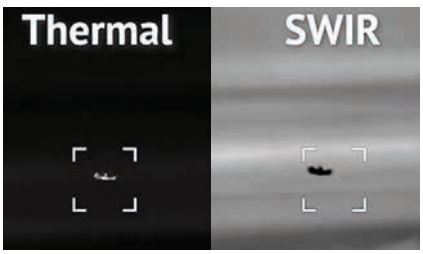
Controp Stamp and EO/IR technology for counter-drone systems

Controp Precision Technologies Ltd., specialising in electro-optics and IR defence and homeland security solutions has unveiled its cutting-edge systems designed for integration into a variety of counter-drone systems.

With contemporary drones sometimes as small as the palm of one's hand, their detection, classification and interception is a significant challenge for defence and homeland security (HLS) officials. Once the drone has been detected, the challenge is to classify the threat with pinpoint accuracy, facilitating efficient activation of counter measures, whether jamming, interception or neutralisation. New counter-drone capabilities have been implemented in a variety of Controp's systems, such as the Speed-ER system, which provides for extremely long-range operations and the SIGHT system for mobile vehicular use, while new software provides for drone identification, classification and tracking.

Suitable for installation on stationary locations or for mobile and deployed applications, the systems are slewed to the area in which a drone has been detected and can track, automatically classify and identify the smallest of drones, at distances of up to several kilometres. Ideal for use in urban environment as well as airports and other strategic facilities, the multi-spectral systems incorporate day and thermal sensors, as well as Shortwave Infra-Red (SWIR) sensors.

Controp is now offering its new software for drone classification, enabling automatic classification of drones in the video image. The advanced image-processing algorithms were specifically developed to meet challenging anti-drone scenarios, with an interface that is compatible and easy to integrate into command and control systems, and can be customised to meet the operator's exact requirements.



Controp has also unveiled new STAMP payloads for future tactical mission requirements, including the T-Stamp-XD for laser-designation missions, and the Stamp-VMD for wide-area persistent surveillance. These lightweight, ruggedised gyro-stabilised miniature payloads have been operationally proven in the most challenging security and defence programmes worldwide.

A new product featured by Controp is the MD-STAMP; the newly-released laser-designator capability for small UAVs and drones, which is the latest product in the STAMP family of miniature payloads. Weighing less than 1kg, this compact laser-designation surveillance and targeting system closes the sensor-to-shooter cycle for tactical missions, while supporting ammunitions with laser humming seekers. The MD-Stamp has been designed for use on drones and on small Group 1 UAVs, and is a miniature version of the T-Stamp-XD, which is a 5.7kg laser-designator system for Group 2 UAVs. Both systems have a day channel as well as an IR camera with a continuous zoom lens for night missions. Using the integrated equipment and firepower, these systems enable tactical forces to close the fire loop.

Controp's Stamp-VMD is a wide-area persistent surveillance system that provides real-time monitoring of areas spanning up to 1km^2, at high resolution. Designed for installation on Group 1 UAVs and drones, this compact payload weighs only 1.3kg and can fly under the cloud ceiling at 1,500 ft. Fitted with an advanced multi-megapixel day camera, it also features automatic movement detection and tracking capabilities, enabling simultaneous monitoring of multiple targets. Equipped with a new, unique integrated sensor data processer, the Stamp-VMD performs onboard image processing, with the onboard detection algorithms enabling use of a standard datalink and minimal bandwidth to send optimized images to the ground station.

Whilst both the T-Stamp-XD and the Stamp-VMD may be used as standalone solutions, when combined they offer a comprehensive, integrated solution for laser-guided munitions, facilitating better decision making, more efficient battle management and accurate assessment of mission success.

Controp specialises in the development and production of electro-optical and precision motion control systems for surveillance, defence and homeland security. Controp's main product lines include: high-performance stabilised observation payloads used for day/night surveillance onboard UAS, small UAS and aerostats/balloons, helicopters, light aircraft (A/C), maritime patrol boats, remote weapon stations and ground vehicles; automatic intruder-detection systems for coastal and border surveillance, port/harbour security, the security of sensitive sites, ground-troop security and anti-drone applications; thermal imaging cameras with high-performance continuous zoom lens and state-of-the-art image enhancement features, and more.

The Gripen, with its Smart Support Solution

"The Gripen is a unique fighter system, bringing about a perfect balance between performance and cost-efficiency". Throughout its design and construction, Saab has ensured that the Gripen is easy to service and repair, making it possible to offer moderate operational and maintenance costs that no other aircraft comes close to matching.

The genesis of Gripen's *smart support solution* dates back more than 80 years, and started back in 1937 when it was clear that Europe was on the brink of a major conflict. Although Sweden, a small neutral country had been at peace for more than a century, its government and industry decided to prepare for the worst. Saab was founded with the mission to secure the nation's supply of military aircraft as part of its drive to maintain national security and sovereignty.

Being a country with very limited resources, but at the same time placed at a strategic location and hence vulnerable, it soon became apparent that something very special was required to mitigate the threats but within available resource limits. By applying smart and innovative thinking, the Swedish Government, its defence forces and Saab managed evolve basic requirements that would apply to all aircraft designed and produced by it these requirements being as they were in 1937.

Essentially, the approach was that the aircraft be able to operate from regular Swedish roads with a straight length of at least 1 km, thus establishing 'secret' road bases. This meant that, in case of war, it was possible to spread the operations to a large number of locations all over the country, rather than being confined to known air bases. Such a spread out made it almost impossible for an enemy to take the air force out of the war equation.

Also, the aircraft should be so easy to maintain that maintenance could be done by a small number of conscript mechanics with only one certified technician. Finally, the aircraft should allow for very fast turn-arounds on the road bases as well as a very quick engine replacement if required. After the final decision to implement the road base system in the 1950s, the road network in Sweden was adapted to meet such requirements.

Efficient support solution

During years of the Cold War, Sweden felt threatened by the Warsaw Pact countries, and the country needed an aircraft that could outperform and out manoeuvere a larger force of contemporary fighters. Northern Sweden is an unforgiving land with long, freezing winters and largely unpopulated areas, presenting a harsh environment in which to operate an aircraft, yet it was this place that gave birth to the Gripen : defending such vast areas required a fighter that could perform air-to-air, air-to-surface and reconnaissance missions.

Sweden's relatively small defence budget and the stringent conditions for which the Gripen was designed, led Saab to make the fighter as efficient as possible. A fundamental aspect of this approach is Gripen's modular and open avionics architecture and efficient maintainability, which enables the integration of off-the-shelf products wherever possible, as well as continuous development of new functions to meet future needs.

The decision to develop the JAS-39 Gripen was taken in 1982, and its first flight was in 1988. With its unstable design and equipped with a fly-by wire system, increased use of composites and other state of the art technology, this was a completely different fighter compared to its predecessors. The basic maintainability and road base requirements remained however the same, and the unique support solution hence woven into its design from the very beginning which eventually became inherent with the system.

Courtesy: Saab

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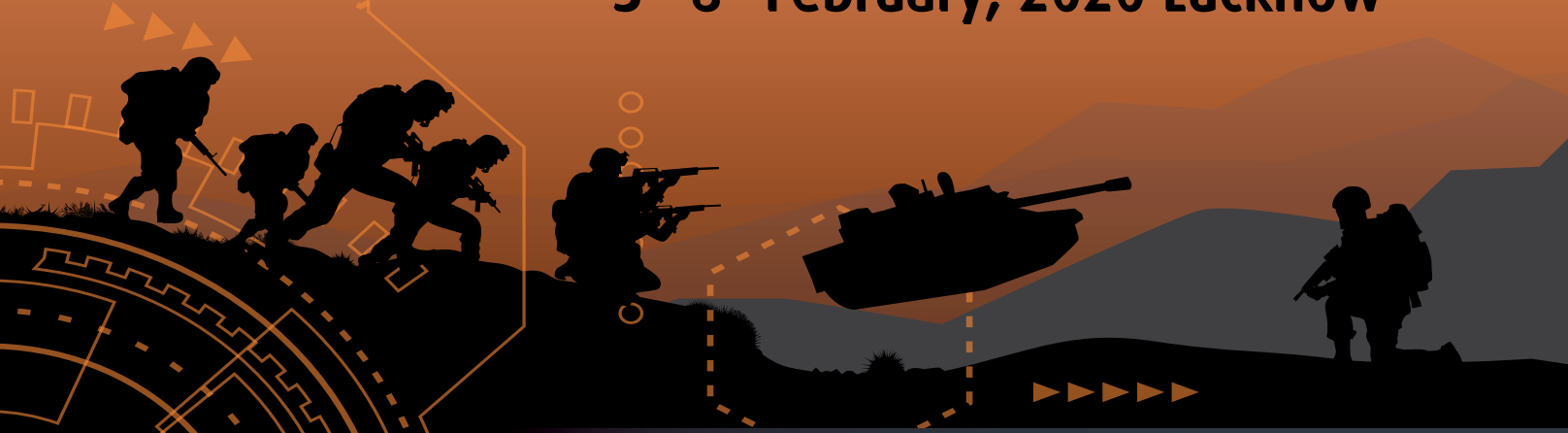

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Nag: the Army's lethal cobra

launch Nag Missile Carrier (*Namica*) in a pack of six with Lock-On-Before Launch (*Lobl*) capability is from 500 metres to 4 kilometres, while the Helicopter Launched Nag (*Helina*) integrated with HAL Rudra (*ALH WSI*) and the HAL Light Combat Helicopter (*LCH*) with Lock-On After Launch (*Loal*) can reach to 7 to 10 kilometres. The radar guided upgraded version (*Helina/Sant*) pushes the range up to 15 to 20 kilometres to facilitate stand-off capability.

The 2.5 km range Man Portable Anti-tank Guided Missile (MPATGM) version is lighter (14.5 kg) in comparison and can be shoulder launched against advancing armour and bunker/fortifications. A 8 kg tandem-shaped charge High-Explosive Anti-Tank (HEAT) warhead, with a precursor and a main charge, provides the weapon with a high kill probability. After the precursor charge penetrates the Explosive Reactive Armour (ERA) of hostile tanks, the main charge is designed to destroy the main armour.

Developed by the Defence Research and Development Organisation (DRDO) for operational deployment by both mechanised infantry and airborne forces of the Indian Army, the *Nag* (Cobra) is an all-weather third-generation, fire-and-forget, Anti-Tank Guided Weapon (ATGW) indigenously developed to counter modern main battle tanks (MBT) and other armoured targets. The ATGW is presently armed with an advanced Bharat Dynamics (BDL)–produced passive Imaging Infra-Red (IIR) Homing Mercury Cadmium Telluride (HgCdTe) Focal Plane Array (FPA) seeker to achieve high single-shot kill probability even in dense electronic countermeasures environment. The missile is optionally offered with a Millimetre Wave (MMW) fire-and-forget Active Radar Homing (ARH) seeker and fired in swarms against advancing high density MBT columns. The *Nag* also features top-attack capability.

The *Nag*'s airframe is built from lightweight and high-strength composite materials featuring four foldable wings and has a length of 1.85 m, diameter of 0.20 m, wing span of 0.4 m and weight of 43 kg. A blunt nose cone houses the guidance system, while the middle portion accommodates a compact sensor package and main charge of the warhead. A booster rocket motor is located towards the rear, and four tail fins are fitted at the rear to stabilise the missile while in flight. A real-time image processor with rapid and efficient algorithms is installed next to the guidance section to provide automatic target detection and tracking capabilities. Control of the missile in roll, pitch and yaw is achieved by moving the rear fins with all electric actuating system using power from the thermal batteries. The digital autopilot offers guidance, stability and control for the missile during the flight.

The Nag ATGW is fitted with a high-energy propulsion system consisting of a booster and smokeless nitramine Extruded Double Base (EDB) sustainer, propelling the weapon to a velocity of 230 metres/second. Range of the terrestrial (*Prospina*) version mounted on the tracking-cum-

The Nag and HELINA seen side by side

Sayan Majumdar

Irkut's 4th MC-21-300 in flight test programme

On 25 December 2019, maiden flight of the fourth MC-21-300 flight test aircraft took place at the airfield of Irkutsk Aviation Plant, the affiliate of Irkut Corporation (a UAC member). The duration of flight was 1 hour 40 minutes, flying at an altitude of 3000 meters at a speed of 500 km / h. The aircraft was piloted by Roman Taskaev and Oleg Mutovin, test pilots, *Heroes of Russia*. According to the crew, "the task was performed completely, the flight was in normal mode". The test results of the first three test MC-21-300's were verified.

Irkut Corporation is conducting MC-21-300 flight tests to obtain Russian and European type certificates. The work involves representatives of the aviation authorities and industry of the Russian Federation, as well as specialists of the European Aviation Safety Agency (EASA).

EASA completes third session of certification flights

Flight test crew of the European Union Aviation Safety Agency (EASA) have completed third flight session of the MC-21-300 certification programme, having worked with their Russian colleagues on the flight simulator. Subsequently the EASA and Yakovlev Design Bureau (a branch of Irkut Corporation) carried out a series of flights on the MC-21-300. In 2019 EASA experts completed two flight sessions in the MC-21-300 certification programme.

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HAL at DefExpo 2020: on home ground!

Light Combat Helicopter (image by Phil Camp)

Tejas LCA (image from Deb Rana)

As nodal agency for organising and conducting the DefExpo 2020, in coordination with the Defence Exhibition Organisation (DEO), Department of Defence Production (DDP), Hindustan Aeronautics Limited are pre-eminent at this, the 11th biennial event taking place at Vrindavan Yojana in Lucknow. With focus on 'Digital Transformation', DefExpo 2020 will witness large scale participation of a diverse global audience, with some one thousand exhibitors, both international and Indian.

HAL's Accessories Division is headquartered at Lucknow's Indra Nagar, most appropriately along 'Tejas Marg'. Established in 1970, HAL's Accessories Division at Lucknow has as its prime objective the manufacturing of aircraft systems and accessories for aircraft, helicopters and their power plants. The facilities are spread over 116,000 sqm of built area set in sylvan surroundings. Presently over 1400 different types of accessories are manufactured or maintained by the Accessories Division, Lucknow.

HAL's production portfolio over its several Divisions in various parts of the country is vast and varied but at DefExpo 2020, are being showcased certain contemporary aircraft and helicopters including the Tejas light combat aircraft (LCA), light combat helicopter (LCH), advanced light helicopter (ALH), the Dornier 228 light transport aircraft (LTA) and Hawk advanced jet trainer (AJT). These will be displayed in model form although planned are flying displays over the venue at select times and would include the ALH Mk.IV Rudra, civil variant of the Dornier 228 and the Tejas light combat aircraft.

A range of the avionics, accessories, components and systems such as the indigenous digital map generator (i-DMG), engine & flight display unit, GTEG-60 engine, air producer engine, glass cockpit for the Dornier 228, automatic target recognition (ATR), digital sand rapid prototyping technology and others will be displayed.

Attracting much attention would be the upgraded Su-30 MKI cockpit simulator is proposed to be displayed during the event. Further an example of the Light Utility Helicopter (LUH) will be showcased at the outdoor display area.

HAL Dornier 228 and Hawk-i (image by Phil Camp)

HAL Light Utility Helicopter (image by Phil Camp)

"Robust and Diverse Portfolio"

Lockheed Martin commitment to advancing India's strategic security, industrial capabilities

C-130J

In showcasing their robust and diverse portfolio of defence and civil capabilities at the 11th biennial edition of Defexpo India-2020, Lockheed Martin, the global security and aerospace company stated, "We're proud to participate here where we can showcase our commitment to 'Make in India' directly to the largest gathering of defence and aerospace partners in the country," stated William (Bill) Blair, Vice President and Chief Executive of Lockheed Martin India. "Lockheed Martin continues to build upon its more than three-decades of partnership with India, expand collaborations with local industry to support the evolution of indigenous defence manufacturing ecosystem, and further advance India's strategic security and industrial capabilities."

Blair added that Lockheed Martin's goals at the show include building on the company's existing foundation in India by identifying additional strategic partners from across the country, to include companies of all sizes — large, Micro, Small & Medium Enterprises (MSMEs) and start-ups. "For the past decade, we have supported the growth and development of India's innovation and start-up ecosystem, and look forward to strengthening those partnerships to support the advancement of India's defence industry well into the future," Blair stated.

The F-21 fighter aircraft, which is on offer for the Indian Air Force, takes centre stage at Lockheed Martin's display. An F-21 cockpit demonstrator is positioned at the booth for defence and aerospace partners to "fly" the jet for themselves, experiencing "its unmatched performance". The F-21 demonstrates Lockheed Martin's commitment in delivering an advanced, scalable single-engine fighter to the Indian Air Force that also provides "unrivaled industrial partnership opportunities – for India, from India".


"F-21 For India, From India"

MH-60R

Another platform being highlighted is the MH-60R *Romeo* Seahawk helicopter, on offer to the Indian Navy. "The MH-60R is the world's most advanced maritime helicopter and will bring vital anti-submarine and anti-surface warfare capabilities to the Indo-Pacific region".

Boosting Lockheed Martin's presence at the show is the C-130J Super Hercules and the S-92 multi-role helicopter, both of which represent a strong legacy of partnership with India and the Indian defence industry. The Indian Air Force operates 12 C-130Js, using the tactical airlifter "to go anywhere to do everything". India also is connected to the C-130J programme through Tata Lockheed Martin Aerostructures Limited, a joint venture, which has the distinction of being the single-global source of C-130J empennage assemblies included on all new Super Hercules aircraft. All C-130Js now built have major components manufactured in India.

On prominent display is the Javelin Anti-Tank Guided Missile system, which versatile and effective one-man-portable and platform-employed anti-tank and multi-target precision weapon system. With a range of 65 meters to 4 kilometers in most operational conditions, as well as the ability to operate through adverse weather and battlefield obscurants, the Javelin can be deployed in a variety of environments and conditions.

Also highlighted is the Modernised Target Acquisition Designation Sight/Pilot Night Vision Sensor (M-TADS/PNVS), the advanced electro-optical fire control system used by AH-64D/E Apache helicopter pilots for long-range precision engagement.

Lockheed Martin has currently integrated more than 70 Indian suppliers including MSMEs into its global supply chain. At DefExpo 2020, the company representatives will seek to discuss partnership opportunities with Tier 1 suppliers and prospective Indian industry partners that strengthen India-US defence industrial ties and 'Make in India' opportunities.

As a part of its larger commitment to enhance the growth and development of India's innovation, Lockheed Martin has sponsored and supported the *India Innovation Growth Programme* (IIGP) since 2007 with the Government of India's Department of Science and Technology. In 2019, the company established MoUs with three Indian startups - Terero Mobility, Sastra Robotics, and NoPo Nanotechnologies integrating them in Lockheed Martin's global supply chain, contributing to the evolution of both the Indian and global aerospace and defence industry.

William (Bill) Blair, VP and Chief Executive of Lockheed Martin India

MQ-9B SkyGuardian completed the first trans-Atlantic flight of a MALE RPA in July 2018

GA-ASI's MQ-9B

GA-ASI's Certifiable Ground Control Station (CGCS)

New Multi-Mission Aircraft brings new capabilities to RPA

MQ-9B SkyGuardian and the maritime variation, SeaGuardian, from General Atomics Aeronautical Systems, Inc. (GA-ASI), will become the world's most advanced Remotely Piloted Aircraft (RPA) when the first variant is delivered to the UK Royal Air Force (RAF) as the Protector RG Mk1 in the early 2020s.

Demand for MQ-9B throughout the world is building. The Australian Government has selected GA-ASI's MQ-9B SkyGuardian to provide the Armed RPAS for the Australian Defence Force (ADF) under Project Air 7003. The Government of Belgium has approved Belgian defence to negotiate the acquisition of SkyGuardian to meet the nation's RPA requirements.

In India, the Ministry of Defence (MOD) has ordered the procurement consideration to be expanded to include the Indian Air Force and Indian Army, ensuring a larger purchase of aircraft than was originally envisioned for the Indian Navy. This larger purchase will allow the already low cost of the unmanned platform to be maximised by economies of scale. There will also be economies when the areas of personnel and sustainment are considered, particularly among the three services.

For the Indian Air Force specifically, sources stated that the procurement of the MQ-9Baircraft will accelerate the sale of the GA-ASI jet powered Avenger, bringing yet another 'game changing' capability to India.

The MOD's decision will also allow for the services to customise the aircraft to fit their particular requirements. The SkyGuardian aircraft is highly modular and is easily configured with a variety of payloads and weapons. With the signing of COMCASA in 2018, the aircraft will include a US tactical data link that will allow the Indian Armed Services to be truly interoperable.

MQ-9B is a ground-up redesign of earlier variants. This was done in order to earn certificationto fly in non-segregated airspace and integrate seamlessly with manned aircraft. GA-ASI expects MQ-9B to achieve certification in the early 2020s, when the aircraft initially will meet NATO STANAG-4671 airworthiness standards, and subsequently will meet commercial airworthiness certification standards in cooperation with the U.S. Federal Aviation Administration (FAA).

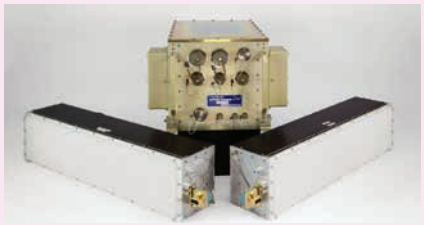
As a truly multi-mission aircraft, nine external hard points on MQ-9B offer unmatched configurability to meet diverse mission requirements. In the basic Intelligence, Surveillance, and Reconnaissance (ISR) configuration, the standard SeaGuardian is equipped with ahigh-definition Electro-optical/Infrared (EO/IR) sensor and a high-performance 360° multi-mode maritime radar to support maritime patrol and surveillance missions. MQ-9B boasts a max airspeed of 210 KTAS and an endurance of more than 40 hours.

In addition to exceptional endurance, SeaGuardian can provide countries with state-of-the-art sensors that offer unparalleled ISR capabilities for a wide range of operational and threat environments. Capable of operating at Beyond Line of Sight (BLOS) ranges at altitudes over 40,000 feet and in inclement weather conditions, the MQ-9B can also provide EO/IR Full Motion Video (FMV), Synthetic Aperture Radar (SAR) imagery, and Ground Moving Target Indicator (GMTI) data about potential threats to military commanders in real-time from stand-off ranges without harm to the aircrew.

The platform can also be equipped with a multi-mode maritime search radar, an Inverse Synthetic Aperture Radar (ISAR) capability, and an Automatic Identification System (AIS) detection capability that provides a true Maritime Wide Area Search (MWAS) and allows for the identification and interdiction of maritime targets.

GA-ASI is also developing an Anti-Submarine Warfare (ASW) capability. In October 2017, GA-ASI demonstrated remote detection and tracking of submerged contacts using an MQ-9A RPA. The MQ-9A used sonobuoys to gather acoustic data and track underwater targets. The data was transmitted to the MQ-9A, processed onboard, and then relayed to the aircraft's GCS. The demonstration successfully paired sonobuoy receiver and data processing technology onboard the MQ-9A.

Future developments are planned that include SeaGuardian's ability to carry and dispense sonobuoys and to transmit the acoustic data via BLOS SATCOM. This continuing development offers yet another cost-efficient capability to complement manned maritime patrol aircraft in the prosecution of submerged vessels.



GA-ASI Detect and Avoid DAA system

Thales at Defexpo 2020

Focus on digital transformation in defence & security

At Defexpo 2020, Thales is exhibiting its wide range of products and solutions through a series of demonstrations across four categories: Land, Naval and Air, Digital Transformation and Security.

Displaying its Digital transformation area, is the Thales *Talios* targeting and reconnaissance system, which combines targeting and tactical reconnaissance capabilities in a single pod which able to embed artificial intelligence in the future. Thales is also showcasing its *Pathmaster*, the first fully configurable unmanned mine counter measures system.

Thales' demonstration for land operations includes combat systems such as the fully integrated Soldier System capability, SYNAPS software defined radios among the family of communication devices, armaments and mock-up missiles supporting air defence systems such as STARStreak and light weight multi-role missiles.

In the Security section, Thales is exhibiting its *Live Face Identification System*, a video-based biometric facial recognition system for tracking and recognition purposes. The company is also showcasing *Eagleshield*, a multi-sensor integrated drone countermeasures solution which can detect, identify, classify and neutralise rogue drones flying at low altitude at ranges of up to 7 km.

In the aviation and naval areas, Thales is displaying anti-submarine warfare solutions such as its *Captas* 1 with Aero & Naval connectivity & Identification solutions such as the *Nextwave*, Interrogator Friend Foe TSB 2510 and others.

With its display of those unique digitally-driven technologies across various verticals, Thales is not only reiterating its commitment towards 'Make in India' (and export from India), but also showcasing its upcoming plans in the development and modernisation of the Indian armed forces.

"We are enthusiastic about our participation at DefExpo India 2020 allowing to demonstrate our leadership in technologies that are completely in line with the expo's theme this year–"Digital Transformation of Defence". Our trusted technologies have been helping armed forces and authorities across the world, including India, to prepare, achieve and maintain tactical superiority and ensure national security.

Backed by over six decades of partnering with India, we look forward to continue playing a major role in job creation and skill development especially through our two Engineering Competence Centres in India and our local partnerships" states Emmanuel de Roquefeuil, Vice President and Country Director, Thales in India.

VAYU Interview with

Mr Kishore Jayaraman,

President, Rolls-Royce India & South Asia


Kishore Jayaraman

VAYU : Rolls-Royce has had a long relationship with India. How has the relationship evolved through the years?

Kishore Jayaraman: Rolls-Royce enjoys a long and fruitful partnership with the Indian Armed Forces and is committed to the long-term continuity of this partnership. It was over 87 years ago that Rolls-Royce partnered India with powering of the first IAF aircraft and first commercial airliners. Today, over 750 Rolls-Royce engines of 10 engine types power Indian military aircraft. More over the past 60 years, Rolls-Royce engines have been made in India, under licence by Hindustan Aeronautics Ltd (HAL).

Rolls-Royce is also a long-term partner of both the Indian Navy and Indian Coast Guard, with our MTU engines powering many Indian Coast Guard and Indian Navy vessels, supported by our Service teams present at several locations along the India's coastline.

As the armed forces undertake modernisation programmes, Rolls-Royce is committed to providing them with the best value, and highest quality products possible. We will continue to support today's fleets and strive to further increase their capabilities.

We are also keen to play a role in India's indigenisation programmes. Today, we are already nurturing skills, developing local supplier base and building capabilities. Going forward, we seek to embrace opportunities to co-develop and co-manufacture for the growing aerospace and defence sector with the right Indian strategic partners. This way we not only create value and contribute to local economies but also create an ecosystem that enables the sustainable growth of the sector.

VAYU: After eight decades in India, and various partnerships, how has the 'Make in India' journey been for Rolls-Royce?

Kishore Jayaraman: Rolls-Royce has been a proponent of the 'Make in India' vision having pioneered the manufacturing partnership model for our engines to be 'Made in India' under license by HAL 1956. We have since expanded our supply chain in India through various partnerships with Bharat Forge, Godrej & Boyce, Force Motors, the Tata Group as well as various MSMEs. We source various components from them, with a further goal of sourcing complex commodities from India over the coming years.

One of the biggest initiatives in this area is our joint venture with HAL, called *International Aerospace Manufacturing Pvt. Ltd. (IAMPL),* to manufacture aero-engine components for the technologically advanced Trent family of civil aero engines. Today, IAMPL is a fully accredited benchmark manufacturing facility within the Rolls-Royce supply chain, operating the latest technologies to the highest levels of aerospace compliance. The JV manufactures more than 130 different aero-engine components for the Trent family of products.

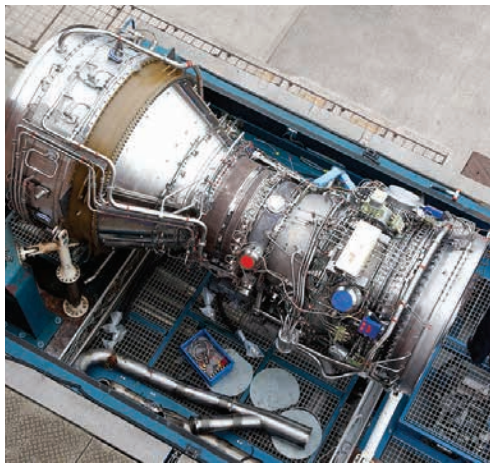
We continually work with our supply chain partners to build capabilities and strengthen skills to enable the aerospace sourcing ecosystem here to meet global quality standards.

In the Power Systems business, Force MTU Power Systems is our joint-venture between Force Motors Limited and Rolls-Royce, to move the manufacturing of the entire line of 1,600 series MTU engines and generator sets from Germany to the manufacturing facility at Chakan near Pune, by 2020. The JV will cater to our customers in both Indian and global markets.

Rolls-Royce is also a big consumer of services from India. Our Engineering Centres in Bengaluru and Pune house a talent pool of engineers contributing to global design and development programmes. Another 1,300 high-skilled engineers work exclusively for Rolls-Royce through outsourced agreements with TCS and QuEST.

As part of our 'Digital First' strategy, our R^2 Data Labs in Bengaluru is our acceleration hub for data innovation, developing data applications that unlock design, manufacturing and operational efficiencies and creating new service propositions for customers around the world.


MTU SmartBridge



The MT30 marine gas turbine

VAYU: What kind of opportunities does Rolls-Royce offer in the Indian maritime sphere?

Kishore Jayaraman: Rolls-Royce is partnering both the Indian Navy and Indian Coast Guard with our MTU brand of products. Within the shipping sector, the company has established a long and successful partnership with some tens of thousands of engines in operation around the globe and on all seas.

Rolls-Royce is firmly committed to serve the needs of the Indian Navy and is keen to customise its advanced technology products to best serve the Navy's power requirements. Our involvement in naval propulsion spans 50 years and we have pioneered some of the most important technical advances in marine propulsion including the use of aero gas turbines for surface ship propulsion.

Rolls Royce's defence business offers the highly successful MT30 marine gas turbine which combines the latest developments in gas turbine technology to deliver greater flexibility to ship designs and outstanding proven performance through life due to its high power density. We have the proven capability required to serve the needs of the Indian Navy for future naval combat readiness and look forward to partnering India in this space.

Then, our latest offering from Rolls-Royce Power Systems business is the MTU Marine Automation EM 50-2 Integrated Bridge System. The modern integrated bridge is the main access point for the information which is essential for safe and efficient operation of ships. With the new solution, previously distributed information is now gathered on a standardised display using a single graphical interface allowing quicker analysis using a modern visual framework.

VAYU: What's your vision for the Indian defence sector in the coming years?

Kishore Jayaraman: Currently, India's defence strategy is undergoing a fundamental transformation triggered by new global and regional geo-political and military developments with greater role for indigenised military technology.

Our view is that instead of pivoting the policy around import substitution and purchases alone, for India to realise its goals of developing a local defence industrial base truly, another parallel strategy should be to actively look into *Indigenisation through Co-development and Collaboration.* And this has to happen across the entire value-chain – from research, design and development to manufacturing, integration, maintenance and repair. As India requires advanced technology and manufacturing capabilities to bridge the existing defence capability gap, there is a need to look at joint production, joint R&D and most-importantly the need to move beyond a buyer-seller relationship. The country's vast talent pool of engineers and scientists should be harnessed to make it a R&D hub. It also needs to consider providing special tax incentives to R&D in defence and sponsoring R&D projects at private industry level to encourage R&D for developing critically advanced technologies.

With this backdrop and along our growing engineering footprint in India, we seek to establish robust ecosystem to enable co-creation across the entire value-chain – from research, design and development to manufacturing, integration, maintenance and repair.

VAYU: What products will Rolls-Royce be showcasing during DefExpo 2020?

Kishore Jayaraman: DefExpo assumes strategic importance as India continues to re-evaluate its military needs and consolidate its current warfare technologies. Our focus at the DefExpo 2020 will be to showcase our capabilities to partner India in defence, particularly in the naval marine space.

From our Defence portfolio, we will be presenting the capabilities of the "mighty" MT30 marine gas turbine that is derived from aero Trent technology. It's just over ten years since the MT30 first powered the US Navy's Littoral Combat Ship (LCS) USS *Freedom*. With a growing demand for power across the world's navies, the world's most power-dense in-service marine gas turbine is finding favour across the globe.

MT30 offers a superior power-to-weight ratio, generating up to 40MW from a 30-tonne packaged unit, including most of the auxiliary systems. It gives navies more power in less machinery space than alternative engine types, and offers ship designers much more options and flexibility in designing the naval vessels of tomorrow. The MT30 also supports the 'lean manning' concept by virtue of its ultra-low on-board maintenance requirement.

One of the key strengths of the MT30 is that it has the power for today and also tomorrow. With growing demand for electrical power, MT30 will meet those future demands. This is one of the reasons that in just over a decade, the MT30 is operating or has been selected in all conceivable propulsion arrangements across seven ship types – mechanical, hybrid and integrated-electric, with power delivered to water-jets, controllable and fixed-pitch propellers, depending on application.

From our Power Systems business, MTU engines currently propel and power many Indian Coast Guard and Indian Navy vessels, as well as powering the Indian Army's Arjun Main Battle Tanks. We now hope to familiarise our Indian defence customers with the MTU Marine Automation EM 50-2 Integrated Bridge System. The modern integrated bridge forms the central point of access to all information that is crucial to safe and efficient ship operation. With the new MTU solution, information previously scattered over diverse displays is now collated at a standardised display using a single graphic interface which enables faster overview using an ultra-modern visuals concept.

By making all data available centrally, the information coming from the various sub-systems can be combined and processed using digital analysis. These findings can then be used, for example, to increase availability, reduce life-cycle costs and further enhance operational reliability.

In addition, we remain committed to serving India's defence needs through our vast portfolio of technologically advanced products, as well as through collaboration for co-development initiatives.

"India Critical to Boeing's International Growth"

VAYU Interview with

Dennis Swanson,

Vice President, International Sales, Boeing Defense, Space & Security and Boeing Global Services

***VAYU**: Boeing has been building its presence in India for decades and has won many defence contracts. What would you attribute to these successes?*

***Boeing**:* As one of the fastest growing economies in the world, India offers growth and productivity opportunities. In addition, as an aerospace leader, Boeing understands the need to play an inspiring role to promote aerospace innovation and build the next generation of engineering talent and frontline workforce across the globe. India offers us that opportunity. As a result, Boeing has established a growing defence installed base, invested in manufacturing, skill development and engineering in country, and contributed to an ecosystem that is being built on technology advancement and innovation.

In addition, over the past decade, we have seen great positive energy and strong participation across our governments. An expanded partnership between the United States and India allows us to create greater prosperity for both our nations and stands as mutually reinforcing engines of growth and innovation. Today, backed by increasing cooperation between the US and Indian governments, our defence products and services are significantly contributing to a closer security partnership and increased defence trade. Of the more than $18 billion defence trade between the two countries, Boeing's defence business constitutes 75% of that share in India. At the core of that is Boeing's commitment and promise to deliver on our commitments to our India customer.

***VAYU**: As the leader for global defence sales for Boeing, how do you see the market for your portfolio internationally?*

***Boeing**:* Our international business is strong and opportunities are growing: international orders based on backlog currently represent 40% of Boeing Defense, Space & Security's business and there is continued opportunities for growth.

Customers around the world are showing significant interest in our portfolio, that includes fixed-wing military and surveillance aircraft, commercial derivative aircraft, military rotorcraft, vertical lift, satellites, human space exploration and autonomous systems. In addition, we also have significant aftermarket support opportunities for mixed fleets worldwide, focused on differentiated and cost-competitive service solutions, regardless of the equipment's original manufacturer.

India is at the front and centre of many those opportunities with the armed services having invested in advanced capabilities for now and the future. We look forward to continue engaging with Prime Minister Narendra Modi and his government, with our armed services customers and with our Indian partners and suppliers – who are absolutely critical to helping us build India's future in aerospace

VAYU : We see renewed cooperation and an upswing in ties between India and the US. What does that mean for Boeing?

Boeing: The defence cooperation environment between the two governments has changed considerably in the last few years and you see more cooperation in areas such as joint military exercises, technology transfer, collaboration through co-production, *Defense Technology and Trade Initiative* and the renewal of the defence agreement for another 10 years by the U.S. Congress.

Maritime security in the context of the military-to-military relationship has significant potential and is the surest foothold to advance the broader security agenda and realise the value of being Major Defence Partner in the near-term. The *Malabar* military exercises and the revival of the Quadrilateral Security Dialogue, the *Quad*, are a natural fit for collaboration. The utilisation of the P-8 fleet for missions in the Indian Ocean region is another way. Collaboration and engagement via the *DTTI Carrier Working Group* will facilitate the exchange of ideas related to carrier operations and the potential for consulting on future design. There is strong potential for Boeing's F/A-18 Super Hornet to be an anchor of maritime cooperation between the two navies.

VAYU : On the F/A-18, what are the broad contours of Boeing's offer to India and how will enable closer ties between the two navies?

Boeing: Our F/A-18 Super Hornet Block III offers the Indian Navy a unique and differentiated capability in the form of an advanced, combat proven, multi-role naval fighter that is fully compatible with the Indian Navy carriers and would boost the growing maritime and defence relationship between the United States and India. Designed as a carrier-based fighter for high- loading, high stress operations with minimal support equipment required, the Super Hornet Block III is fully compliant with and ideally suited for the Indian Navy's carrier deck, and as demonstrated in flight trials, can take off from Indian aircraft carriers via the ski jump ramp. It is also compatible with air refueling tankers operated around the world.

The Hornet seen here at Aero India

With the Super Hornet being the frontline fighter for the US Navy, cooperation between the two navies in naval aviation can result in the sharing of upgrades and knowledge. The F/A-18 can unlock the potential of cooperation in naval aviation, with the sharing of best practices in modern naval aviation systems, carrier integration know-how, services and training and weapon systems. In addition, the F/A-18's integration with Indian carriers would demonstrate India's commitment as a 'Major Defence Partner' and the 'Asia Pacific Reassurance Initiative,' serving as an important symbol of the new relationship between the United States and India.

BAE Systems: "Depth of Partnerships in India"

Two BAE Systems M777 Ultra Lightweight Howitzer (ULH) gun systems are taking centre stage at DefExpo 2020. The two M777 ULH systems signify the 145-gun agreement between the US and Indian governments to strengthen India's artillery capabilities. Under the agreement, 120 ULH systems are being assembled, integrated and tested in India by Mahindra Defence Systems Ltd. (MDSL), as part of the 'Make in India' programme. To date, BAE Systems has produced and delivered 25 guns to the Indian Army, with another 70-plus planned for 2020.

Nik Khanna, BAE Systems' Managing Director India, added: "BAE Systems is proud to be a founding partner of defence manufacturing in India, and DefExpo 2020 is a great occasion to engage further with our key Indian stakeholders, strengthening existing partnerships and exploring avenues for new ones, particularly around the Mk45 naval gun. The team also looks forward to using this opportunity to discuss the continuing development of BAE Systems' in-country supply chain, which the company is committed to expanding."

The M777 Ultra Lightweight Howitzer (ULH) gun system at Defexpo'16

In addition, the BAE Systems stand at DefExpo 2020 (R32, Hall 7, UK Pavilion) is exhibiting an array of state-of-the-art capabilities, including towed and self-propelled artillery, naval gun systems and ships, ammunition, unmanned autonomous systems and precision munitions. Dave Armstrong, BAE Systems' Group Business Development Director, stated, "India is a strategic market for BAE Systems and DefExpo 2020 provides the company with the ideal platform to showcase the deep collaboration and commitment that exist with the Indian government and across industry, highlighted best by the ongoing success of the M777 ULH programme."

At DefExpo 2020, BAE Systems is exhibiting a 3-Dimensional video of its Mk45 Mod 4 naval gun, the lightest, most compact, fully automatic 127mm naval gun in the world. With a dozen customers globally, including the US and United Kingdom, the 62-calibre Mk45 naval gun can provide a firing range of 13 nautical miles with conventional munitions. The gun has been successfully tested with the Vulcano 127mm long-range precision munition, which the company is also displaying.

Building on continued interest in India, and highlighting its expertise in warship design, BAE Systems is showcasing a model of the Queen Elizabeth Class Aircraft Carrier at its stand at DefExpo 2020. A model of the 'Make in India' Hawk advanced jet trainer, which is in service with the Indian Air Force and the Indian Navy, is also on display.

An array of munitions are being exhibited by BAE Systems, including the 57mm and 40mm programmable 3P Ammo, BONUS 155mm sensor-fused ammunition, 5-inch (127mm) Vulcano, and 120mm Tank ammunition, CT40 cannon. The APKWS laser-guidance kit is being featured on the stand. The low-cost, combat-proven APKWS kit transforms standard 2.75-inch (70-millemeter) rockets into precision munitions that reduce collateral damage. The guidance kits are compatible with existing and new inventories of rocket motors, warheads, and launchers; are easy to install; and require minimal training to use. With APKWS, rockets have achieved over a 93 percent hit rate in combat, have been fired from more than 20 different platforms, and are available to allied nations via Foreign Military Sales from the US Government.

M777 image from Defexpo'16

Lt Gen Kamal Davar reviews

China's Spectacular Rise

and suggests

Shaping the Indian Response

China's splendid isolation nurtured a particular Chinese self-perception, Chinese elites grew accustomed to the notion that China was unique---not just a "great civilization" among others, but civilization itself.

Henry Kissinger

Some 200 years back, Napoleon had prophetically expressed that "let China sleep, for when she wakes, she will shake the world." Unquestionably, China has gone far beyond this axiom, and the world acknowledges that. Over the past two decades or so, China has been one of the world's fastest growing economies with foreign reserves now estimated at over $ 3.4 trillion and fielding what is regarded as the second most powerful armed forces in the world. China is fast catching up with the now economically weary and the strategically fatigued United States of America. China's spectacular rise naturally translates into its ever growing global clout, propelling it to have unbridled geo-political and military ambitions – not only in Asia but world-wide.

China's burgeoning financial, and consequently military might, continues

on a rapid upswing, synergised by its ancient civilisational wisdom of realpolitik embellished by strategic vision and nationalistic ambitions which are unparalleled. That China will be a 'super power' by 2030, if not earlier, is understating the stark reality. If the 21st Century has to be an Asian one, as repeatedly proclaimed by many geo-political luminaries, China leads the way well ahead of other players on the scene including India, Japan, S. Korea, Vietnam, Malaysia and some others. China is usually bracketed with India (and Japan) as also lead players in *Emerging Asia*. However, commentators opine that India is merely plodding along, not really rising to its true potential owing to so many inner contradictions. As noted US analyst George Tanham once pithily noted, "India lacks strategic culture". Still, China regards India as its main rival, globally, regionally, economically and militarily, which makes the growing asymmetric chasm between the two neighbours (and Asian giants), a cause of serious worry for India. Although India is an ascendant power, how will it would cope with the rise of China is, perhaps, going to be the most acute military challenge for us in the foreseeable future.

An analysis of China's stated aims

Even as China builds up a formidable military machine, it is conscious of inculcating a responsible image to the world in keeping with its growing global status. Since 1998, China has been issuing 'White Papers' every two years on its National Defence, these papers comprehensively covering all macro-issues concerning this as also China's stated aims.

The aforesaid 'White Papers' encapsulate China's pursuit of a defence policy which ensures a stable security environment and permits the development of its economy and the modernisation of its military. Importantly, it stresses military power as a guarantor of China's strategic autonomy to ensure that China continues to enjoy unrestricted access to critical strategic resources including oil and natural gas. China further stresses that its national defence policy is primarily *defensive* in nature and that it would launch counter-attacks only in self-defence, further claiming that it "plays an active part in maintaining global and regional peace and stability." China continues to proclaim that it follows a "no first use" nuclear doctrine and is "a responsible nuclear and space power".

However, most strategic analysts in the world over, particularly its neighbours, dismiss China's noble-sounding rhetoric as little more than a public-relations exercise as China's actions in the past few years, across Asia, have been anything but contributing to regional harmony. On the contrary, China is well on the way to become a regional hegemon as many of its actions clearly show, particularly the turbulence created by muscle-flexing in the many waterways which lap the Chinese coastline, whether it is the South China Sea or the East China Sea including its many claims on various island territories in the region. China even scoffs at the US and other maritime powers including France, Japan and Australia in the Indian and Pacific Oceans region which is a well acknowledged matter.

One of the manifestations of the changing Chinese doctrine was introduction of a new cliché in the lexicon of Chinese think tanks, that being the *Grand Periphery Military Strategy*, which presupposes the fact that the People's Liberation Army, surprisingly to many, actually lacked the capability of defending its 'far flung

PLAN warships on exercise

borders.' Now Chinese military thinkers are reinforcing a newer strategy to be adopted in the face of the rapidly changing geopolitical dynamics in South, Central, South East and North East Asia. However, such thinking appears to have petered out a few years back, with the Chinese now concentrating on their globally ambitious *Borders and Road Initiative*, the Chinese in recent years having reorganised their entire overall defence management structures.

China's One Belt and One Road (OBOR) Initiative

Since advent of President Xi Jinping on the nation's political firmament, China is truly "thinking and acting globally". The OBOR initiative was first announced by President Xi in 2013, which grandiose concept is rooted in history and generally conforming to the ancient Silk Routes which once linked the great Chinese Empires to the heart of Europe. However, in its proposed avatar, the OBOR will follow both the land route, referred to as the *Silk Road Economic Belt* and the sea route labeled as the *21st Century Maritime Silk Road*.

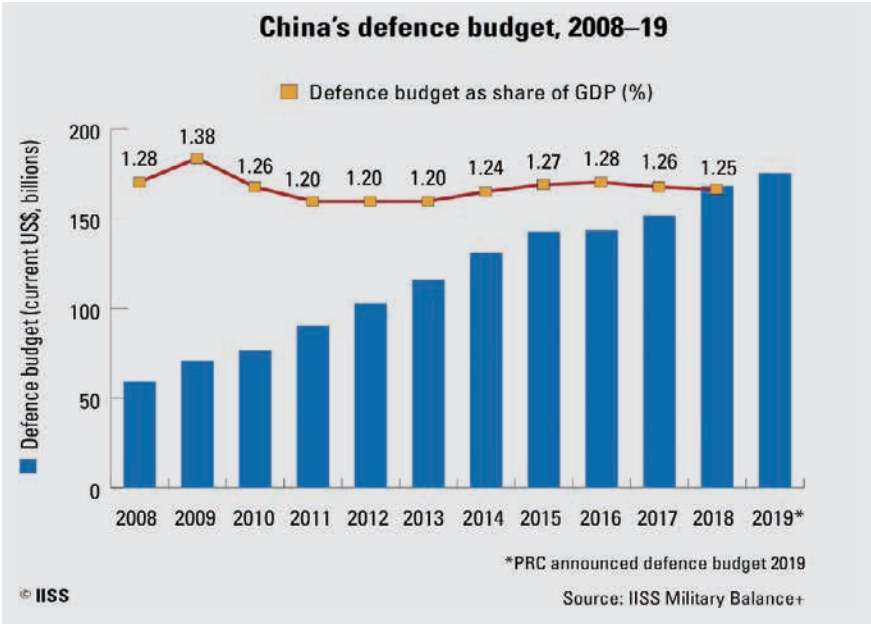
The *Silk Road Economic Belt* essentially comprises a network of roads linking Xi'an in China to Central Asia, Europe, the Middle East, Russia and Europe. Apart from these countries which were once linked along the ancient Silk Road, more nations of Southern and SE Asia have now been included. There are six major project corridors envisaged, the two most important ones in India's vicinity being the $ 62 billion budgeted China-Pakistan Economic Corridor (CPEC) which links Kashgar in China's Xinjiang with the deep-sea port of Gwadar in Pakistan, traversing the disputed territory of Gilgit-Baltistan (GB) and Pakistan occupied Kashmir (PoK). Once it becomes fully functional, China would have to some extent successfully overcome, '*The Malacca Strait Syndrome*'. The other in India's neighbourhood is the proposed Bangladesh-China-India-Myanmar corridor.

Indian officials have not attended the two meetings on the CPEC hosted by China as the CPEC passes through Gilgit-Baltistan (GB) and Pakistan occupied Kashmir (PoK) which is Indian territory under occupation by Pakistan since 1948. "Economic benefits should not transcend a nation's sovereignty" and India has maintained this stance, also not forgetting that the Shakgsam Valley (5180 sq kms) which was part of the erstwhile princely state of J&K, was ceded to China by Pakistan in November 1963.

Some years back, Michael Caine and Ashley Tellis of the *Carnegie Endowment for International Peace* in their seminal work 'Interpreting China's Grand Strategy: Past, Present and Future', have opined that "the continued increase in China's relative economic and military capabilities, combined with its growing maritime strategic orientation, if sustained over many years, will almost certainly produce both a re-definition of China's strategic interests…… that directly or indirectly challenges many of the existing equities."

China's Defence Spending

Freeing China from the restrictive Maoist economic thinking in the mid-70s, China's then leader Deng Xiaoping had unleashed market reforms which *The Economist* aptly summarised as "….. the most dynamic burst of wealth creation in human history." This growing economic clout is translating into military muscle and modernisation of the armed forces at a pace which no country in the world can match. As widely surmised, China's declared defence budgets are normally shown as much lower than their actual value. From US$ 146 billion in 2016,



the Chinese defence budget went up to $ 165 billion in 2018 and the 2019 budget was up by 8.1 percent to a staggering $ 177.6 billion.

China's defence budget exceeds that of all major Asia-Pacific countries put together, with Japan a distant second with around US$ 70 billion. India with a falling rupee depreciation, substantial fiscal deficit and large governmental debts, is far behind in defence allocations with this year's defence budget being a paltry US$ 45 billion. The overall strategic implications for the entire Asia-Pacific region of China's triple digit defence spending can easily be comprehended.

China's Core Interests and Internal Imbalances

It is not surprising to China watchers that its all-pervading assertiveness has led to the definition and usage by both its official and unofficial institutions of its "core interests", which are spreading to embrace newer sensitivities. Earlier, such interests were confined to a few areas where the Chinese Communist Party would brook no dissenting views, which importantly included its national security, national sovereignty and territorial integrity.

Tibet became China's major "core interest" after its annexation in 1951 and so did the island of Taiwan, which was ceded to Japan in 1895, but is today an economically vibrant self-governing democracy, calling itself the *Republic of China*. Its giant neighbour, *The People's Republic of China* has repeatedly warned the world that it would invade Taiwan if it ever declared independence. More recently, the restive province of Xingjian (formerly East Turkestan), the massive region in the west of China, which has seen frequent clashes between the local Uighur Muslims and the Han Chinese being settled there from mainland China, is now also an important part in the list of China's "core interests".

China has also vociferously warned of its "core interests" in the South China Sea as being "non-negotiable", warning nations such as Vietnam, Malaysia, the Philippines and Brunei which lie astride this waterway. China has cautioned the US to keep its naval vessels away from this waterway and some years back, had also aggressively cautioned an Indian naval vessel, INS *Airawat*, which was sailing in the territorial waters of Vietnam where India has been

prospecting for oil. China has now included the sustaining of its existing political system as a "core interest".

However, internal stability currently remains the most critical constituent of China's national security. The significant internal imbalances which worry China are Taiwan, Tibet, the restive Xinjiang-Uighur Autonomous Region but also uneven regional development compared to the east, namely its coastal belt which is far ahead in development indices than the seemingly impoverished western region. In addition, Chinese concerns also embrace its demographic clock where the population is ageing at a rapid rate. It is estimated that by the mid-21st century, more than half of China's population will be over sixty years old. Barry Naughton in his book on the Chinese economy has surmised that "China will grow old before it has had the opportunity to grow richer." In addition, China's growing energy demands to fuel its growth, is causing environmental problems both internally and internationally while unchecked modernisation is also causing severe environmental degradation within China, with acid rain getting worse and its total agricultural land having decreased by some 20 percent.

China's Defence Modernisation

China has shifted gears since the collapse of its major threat, namely the Soviet Union, in the early nineties of the 20th century. Their paramount leader, Deng Xiaoping had ordained that "small and medium local conflicts and not general wars were the most likely threats." Gradually the Chinese have, especially after the Gulf War, honed

their doctrine to consider "Local Wars under Conditions of Informationisation." China's military modernisation strategy is based on the *PLA's simultaneous transformation through mechanisation and informationisation*. The Chinese have been rapidly building up their Information Warfare capabilities, with reportedly 30,000 computer professionals and two 'Hacker Brigades' as part of the Chinese forces.

Strategic Forces: China maintains a strong nuclear deterrence, employing land based ICBMs, with currently around 250 nuclear warheads in its inventory, and the arsenal grows. There are around 60 ICBMs (DF-31 of 8000kms and DF-31A of 13000 kms range). By around 2020, experts opine that it will have 100 ICBMs and 6 *Jin*-class nuclear submarines, each armed with 12 sea-launched ballistic missiles. Besides, there are the DF-16 (improved SRBM), the DF-17 (hypersonic glide vehicles), the DF-26 medium range ballistic missiles. China's Second Artillery Corps has over 1000 short range ballistic missiles with conventional warheads.

Land Forces: The PLA remains the world's largest army with 1.6 million men in its regular forces. As per the *Military Balance*, there are now 81 Combined Arms

Brigades (CABs) and 4 Divisions (to India's 28) with 7660 main battle tanks (to India's 3900) and nearly 18,000 artillery pieces (to India's 10,000). Besides there are nearly 60 Divisions of the People's Armed Police as an internal security force, the bulk of which are demobilised PLA Divisions. The PLA is gradually fielding an ultra-modern tank, the VT-4 MBT, in its armoured formations.

The PLA Navy: To support its ever expanding naval ambitions, not only in the seas surrounding it, but for naval operations against Taiwan and in the entire Asia-Pacific to thwart even the US flotilla and the navies of the other countries in its vicinity, the Chinese Navy is actually the focus of modernisation. By 2025-2030, it could deploy three aircraft carrier battle groups, 60 submarines, including 10 nuclear, and nearly 80 surface combatants. The Indian Navy may just have two aircraft carriers and 16-18 submarines with 2 nuclear submarines and 58 surface combatants by then.

PLAAF: The Chinese Air Force is currently undergoing a feverish qualitative upgrade, its "vintage fleet" being rapidly replaced by fourth and fifth generation fighters such as the Russian Su-27, Su-30, Su-35 and its Chinese copy, the J-11. The indigenous mainstay is the J-10 and also has jointly developed the JF-17 Thunder multi-role aircraft with Pakistan which country is receiving 250 of these (see *Vayu Issue IV/2019)*.

The Chengdu J-20 fifth generation stealth fighter has recently joined service with the PLAAF, and will shortly be joined by the Shenyang J-31 which according to analysts, is comparable with the US F-35, while the Xi'an H-20 stealth strategic bomber is under development. Like India, China has been air-to-air refueling and AWACS capability. By 2020-22, it will have over 2300 fourth/fifth generation combat aircraft compared with the IAF's 750 (in the best possible modernisation scenario) and this asymmetry is a matter of major concern for India. Significantly, China is planning to build some 60 airfields in the Tibetan region alone!

ABMs: China tested its first anti-satellite missile in early 2007 and in 2010 conducted an actual anti-ballistic missile test. It has launched three manned missions and a lunar orbiter and is planning launch of nano satellites that will serve as virtual 'space mines'. By 2020, China plans to have 200 remote sensing satellites plus also a manned military space station: very first in the world

Rapid Reaction Forces: China is developing rapid reaction capability for speedy and potent responses to varying battlefield contingencies. These high-technology based rapid reaction forces will be deployed for small scale intense local military operations or in support of pre-

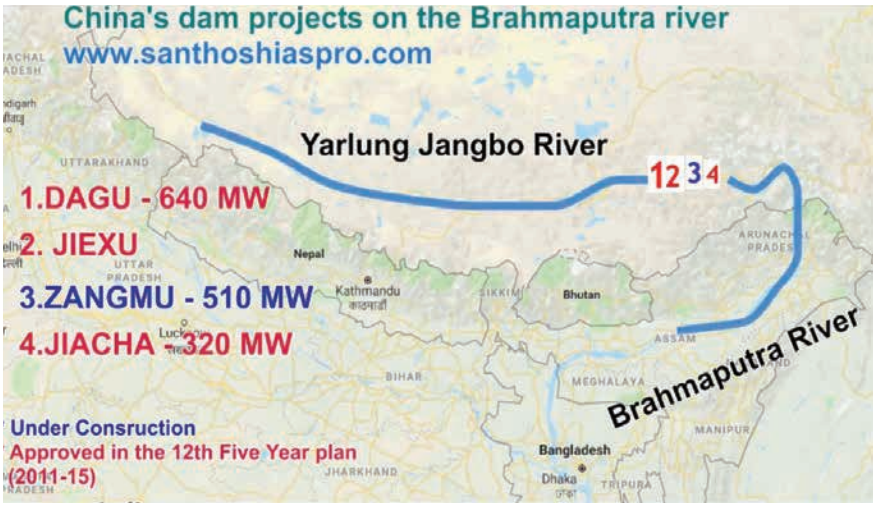
All images from the internet

emptive operations. The Chinese already maintain a fully operational Airborne Corps and according to unconfirmed reports, another Airborne Corps HQ, is under raising. These forces could be tasked also in support of China's "core interests" as specified earlier, whenever required.

China's River Water Machinations

Tibet is the water reservoir of India but China virtually exercises control over the waters of rivers like the Tsangpo (Brahmaputra), Indus and Sutlej flowing into India, thanks to is superior upper riparian position on the Tibet plateau. There are alarming reports that China plans to massively divert waters of the Brahmaputra to its vast arid areas in the north and west. It also has commenced work to dam some other rivers flowing into India. India's hydel project on the Brahmaputra, upstream of Pasighat, has been on hold for a very long time and the callous attitude of China in water management upstream of the Indian rivers has already resulted in two devastating flash floods. In June 2000 parts of Arunachal Pradesh were suddenly flooded after bursting of the Yiong River Dam and release of excess water. In 2005, the river Sutlej was flooded in Himachal Pradesh because of the Pare Chu Lake in Tibet, which caused havoc to many low lying villages in some regions of Himachal Pradesh near the Indo-China border. In addition, the already completed construction of the 116 metres high Zangmu Dam on the Tsangpo in eastern Tibet in a high seismic zone, can well cause havoc in Assam if there was to be a major earthquake in the region.

Although former Prime Minister Dr Manmohan Singh had himself assuaged the concerns of Indian parliamentarians at the Rajya Sabha in August 2011 regarding China's diversion of waters from the Brahmaputra or damming it inside China, India will be well advised to ensure continuous satellite intelligence coverage of China's activities in this area. China is known to keep its river water strategies under strict wraps and does not allow any outsiders for on-site visits, disregarding UN recommendations on water data sharing.



The China–Pakistan Collusion

With Pakistan becoming a near-vassal state of China and considering the strategic congruence between the two nations, a credible collusion between them during a major conflict with India is the future cannot be ruled out. China has viewed India as its primary geo-strategic and economic rival and as it desires to attain total pre-eminence in the region, has a clear strategy to keep India pre-occupied regionally. Overall, for China, Pakistan is a low-cost proxy for the former's machinations in South Asia whilst for Pakistan, China remains a low-cost, albeit high value, guarantor of its security vis-à-vis India.

Importantly, to "influence" the agitating Muslim Uighurs in its Xinjiang province, China needs Pakistan's assistance in ensuring that its own terror groups and even those of the Afghan Taliban, do not reinforce the Uighurs in their fight agitation against the Chinese and must be suitably leveraged.

Such strategic China-Pakistan cooperation which began is the 1960s has, particularly over the past 30th years expanded into multiple domains including the political, diplomatic, military, economic, technical and cultural fields. Very recently, after India abrogated Articles 370 and 35A from its state of J&K, it was China that requested a special closed-door meeting of the UNSC members on the issue.

Thus, critically, apart from myriad aspects of military cooperation with Pakistan, China has accorded substantial assistance to Pakistan's nuclear programme, as also development of satellites and assistance in cyber technologies. Pakistan's missile programmes including the *Ghaznavi*, *Shaheen* and *Nasr* series of ballistic missiles owe their development to China. Importantly, China has massively assisted Pakistan in the transfer of technology and joint production of fighter aircraft, particularly the JF-17 Thunder, a range of UAVs and other systems.

Imran Khan with Xi Jinping

Ominous Future

Notwithstanding several rounds of dialogue between India and China over the last many years on many vexed issues between the two countries – including the contentious border matter – Chinese actions towards India are hardly encouraging. China appears to be still living in the 'Middle Kingdom' syndrome and resents Indian aspirations as a second Asian power. Its 'string of pearls' stratagem dearly aims at the strategic encirclement of India, confining it to the backwaters of the Indian Ocean and restricting India to merely southern Asia.

China's nuclear weapons-cum-missiles relationship with Pakistan and modernisation of the Pakistani Armed Forces, is clearly aimed against India. Since the last few years, the Chinese footprint in the disputed POK region has grown under the garb of road construction engineers being stationed in the region (approximately 7000 to 10,000 personnel already), Media reports suggest that portions of Pakistan-occupied Kashmir have been leased to China for 50 years or more, converting POK as Pakistani territory and in doing so, legitimising the 5180 sq kms ceded by Pakistan to China in 1963. This is now referred to as 'Chinese sovereign territory' and India thus faces yet another front.

China has also made inroads into India's immediate neighbourhood through Nepal, Bangladesh, Myanmar and Sri Lanka, providing them weaponry and military training facilities besides constructing strategic infrastructure.

Prognosis and the Indian Response

Thus, the not-so-peaceful rise of China and its provocative actions as concerns India and already stated in this article, portends more *competition* than *cooperation* between the two Asian giants. China's stated reunification policies make it clear that it would use military power to regain certain parts in its neighbourhood which it perceives to be its own. Thus, even as India endeavours to resolve all contentious problems with China in a mature and peaceful manner, it must get gear up to face the Chinese dragon head-on for China only respects strength.


China's ballistic missiles...

TIME Magazine cover on the China vs India matter

In order to do this, India needs to firstly correctly assess likely Chinese threats, both in the short-term and long term. The Indian government must not play down Chinese challenges in any form. Secondly, we must address with determination the present military asymmetry to counter threats from China and ensure no bureaucratic sluggishness or procedural shortcomings come in the way of the identification and procurement of military hardware for all the three services, within a speedy time-frame. The three Services must became capable of offensive operations and not just remain on the defensive.

Thirdly, India must pay adequate attention in further developing its strategic infrastructure along the Indo-China border. Nuclear and space assets require to be vastly improved as well as electronic and cyber warfare wherewithal. Fourthly, under an international umbrella, we need to formalise either bilateral or regional river water-management treaties between India and China and other Asian lower riparian states.

Finally, India needs to take the lead to energise all Asian groupings such as ASEAN to ensure peace and stability in the Asia-Pacific region – with active cooperation of

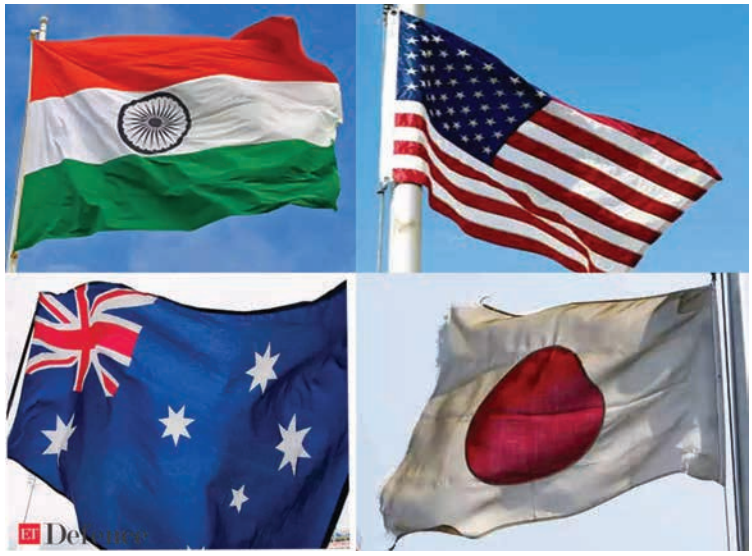


Image of H-20 stealth strategic bomber....

the USA, Japan and Australia. The QUAD formulation, needed for ensuring a rules-based maritime order for the entire Indo-Pacific sea-lanes, must be taken to its logical conclusion.

It is about time that India carries out a reality check of its overall capabilities vis-à-vis China. It now needs to upgrade its military strategy from dissuasion to deterrence. For effective deterrence, India needs to enhance the capabilities of its nuclear forces by fielding long range Agni IV and V Intermediate Range Ballistic Missiles and sea- launched long range missiles by nuclear submarines to complete the nuclear TRIAD.

Synergy of the three Services and India's future military build-up to deter the formidable Chinese will only be effective if the country goes in for long awaited defence reforms in India's higher defence management structure. The 2019 Independence Day announcement by PM Narendra Modi on instituting appointment of a Chief of Defence Staff (CDS) for the Indian Armed Forces was a welcome step but we now also need to establish Theatre Commands to optimally synergise functioning of the three Services. In this context, the Andaman & Nicobar Command must be given far more strategic muscle to adequately thwart Chinese ambitions in the Indian Ocean region.

It must be reiterated that India will only be able to occupy its rightful place on the global high table, if it accords adequate attention to enhancing its combat preparedness. Even as India rightly endeavours to nurture peaceful relations with China, it must never forget the simple truism that China really respects strength even as it feverishly prepares for regional and global dominance. Diplomatic niceties have little place in China's statecraft.

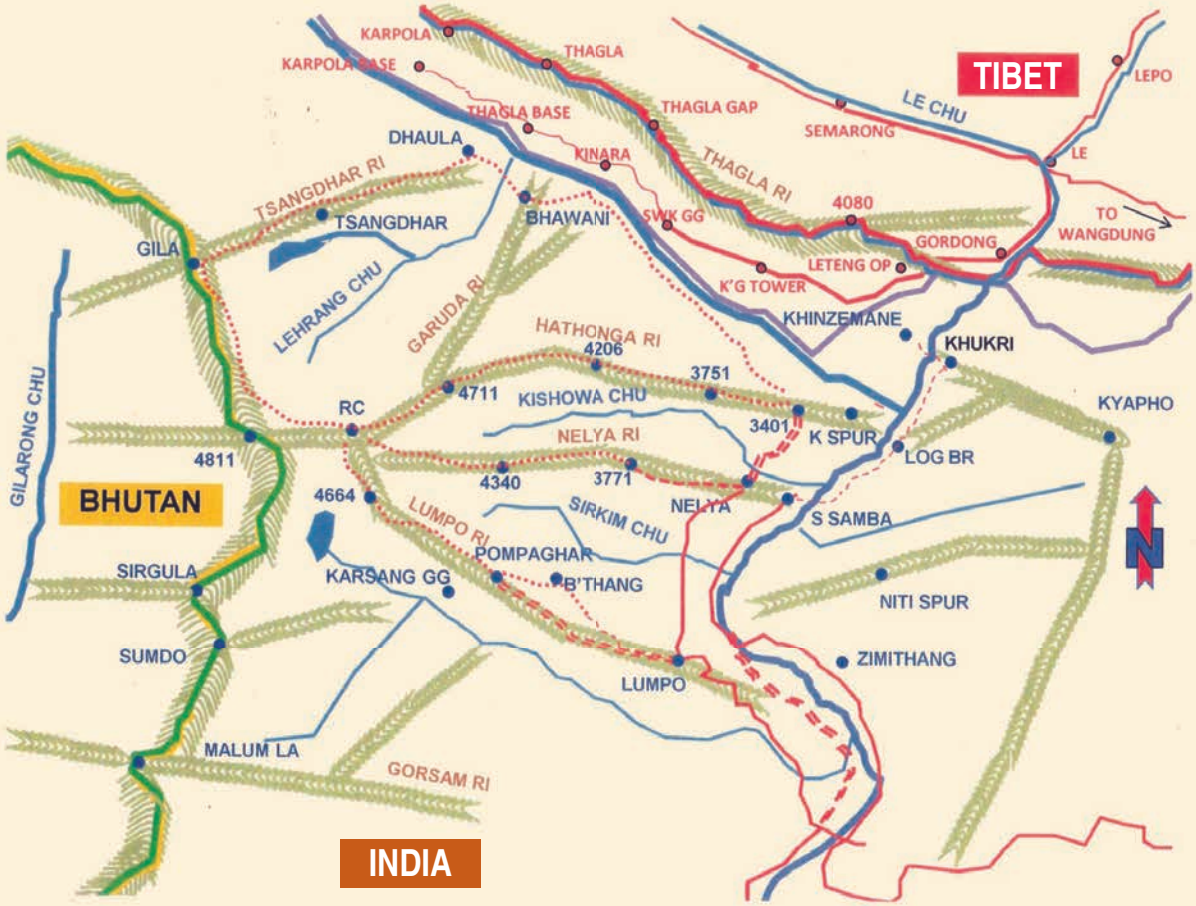
Lt. General Kamal Davar (retd.) was the first DG, Defence Intelligence Agency and Deputy Chief of the Integrated Defence Staff.

...and India's Agni 5

Major General Pardeep K Batra recollects

'Operation Falcon'

The Chinese intrusion in Wandung / Sumdrong Chu in 1985-86



Maps and images courtesy Maj. Gen. PK Batra

In this article, Major General Pardeep K Batra, Commander during 1985-87 of the famous 77 Mountain Brigade ('Chindits') of World War II fame narrates his personal experiences and highlights how this Brigade, as part of the 5th ('Ball of Fire') Division, stood up to the calibrated Chinese aggression, and also assuaged the memory of Hathungla Martyrs' of the 1962 War.

'Amicable' resolution of the 73 day-long *Doklam Stand-off* in June-August 2017 at the India-Bhutan-Tibet Tri-junction area, revived memories of the 1962 India-China border war, particularly of the 'Battle of Namka Chu' and then the later Chinese intrusions in September 1967 and October 1986. The last two incidents were widely reported across the world and the experience gained by the Indian Army and in-depth analyses provided a vital glimpse into the Chinese mind-set and *modus operandi*. Enhanced military capabilities of the Indian armed forces over the years and astute diplomacy has prepared the Nation to confront any Chinese aggression and the multi-pronged rhetoric without wavering.

In April 1985, I was Colonel General Staff 31 Armoured Division, when the duty signal officer rang to inform me of my posting on promotion to 77 Mountain Brigade. I requested him to find out the location of this Formation, took off my jogging shoes and put on DMS boots : the exercise to toughen up for the high mountains had begun !

77 Brigade ('Chindits')

The *Chindits,* officially the *Long Range Penetration Groups,* were special operation units of the British and Indian armies which saw action in 1943–1944, during the Burma Campaign of World War II. The creation of British Army Brigadier Orde Charles Wingate, the *Chindits* were tasked for raiding operations against the Imperial Japanese Army, especially long-range penetration, attacking Japanese troops, facilities and lines of communication, deep behind enemy lines.

The name *Chindits* was suggested by Captain Aung Thin of the Burma Rifles. *Chindit* is a corrupted form of the Burmese mythical beast *Chinthé* or *Chinthay,* statues of which guard Buddhist temples.

The first *Chindit* formation was the 77th Indian Infantry Brigade, which was raised in the area around Jhansi in the summer of 1942 with mixed British, Indian and Gurkha troops, The Indian Army today includes three Gorkha battalions which proudly bear the appellation *'Chindits'.*

The famed Chindits

77 Mountain Brigade, part of the 5th Indian Division, is a legendary Brigade which was raised by Brigadier (later Maj.Gen.) Orde Wingate, trained for operations behind Japanese defences, initially paradroped or by gliders during the Burma campaign and thereafter sustained by air. Its emblem, selected by Wingate for the long range penetration group (LRPG), was the *Chinthe*, a Burmese mythological beast, half lion half eagle which symbolised close cooperation between the ground and air forces. Now, many decades later, the Chindits tradition was revived to prove that a large force could successfully operate, if sustained by 'air'.

After taking over this fine Brigade, I soon got to know my operational area in the high mountains of Arunachal Pradesh (erstwhile NEFA). After 10 days of acclimatisation, I moved off to inspect all locations of my Brigade Sector, being conducted by one of my Commanding Officers. After walking for 12 days at average heights of 12,000 feet or above where one gasps for breath every few minutes of walk, we halted for the night at a place called *Shakti*. That night I overheard the CO telling my Brigade Major, "The Tank run has been very successful". Being a tank man myself, there may have been some apprehensions that I might not be able to make it in the mountains ! I smiled to myself for having earned my `spurs'.

77 Brigade was maintained by air : Mi-17/8 helicopters and An-32 tactical transport aircraft. The Indian Air Force did a commendable job to sustain us till such time that we could improve tracks for mules for carrying the burden. The weather was hostile, with heavy snow prevailing. The helicopters would fly in with rations and defence stores, weather permitting, the same being with air drops to sustain the Brigade. In fact, Lumpo helipad, below Brigade HQs, was wryly named as an 'International Airport' as, weather permitting, every few minutes a helicopter would land or air drops take place. We were not daunted by numerous problems and we kept stocking by air and also by foot along the tracks both at Lumpo and Lungrola.

Helicopters of the IAF were invaluable during the buildup of 77 Brigade's deployment. Seen at Lumpo helipad are an Mi-8 with Cheetah in the background

An-32 air dropping supplies over Gorsam

I had been warned that the locals were not too friendly toward Indians and as I had to win them over, started interacting with them through an interpreter. I also started education classes for children, medical aid for the locals by bringing in uniformed

doctors (including lady doctors) and screening some movies to entertain them. Soon enough this resulted in additional and willing manpower by locals who became friendly and helped us retrieve air dropped stores which would inevitably drift off because of strong winds.

The Chinese Intrusion in August 1986

An incursion by the Chinese Army into Wangdung/Sumdrong Chu south of Zangla ridge was spotted by our patrols from 12 Assam. The Chinese had pitched some tents, but our patrol was then ordered to occupy Langrola, overlooking the Chinese positions to thwart their intention of occupying Langrola.

At Lungrola we continued to occupy heights and established patrolling points (PPs) overlooking Wangdung and so hemmed in the Chinese. The Chinese had employed local porters as also their helicopters to re-inforce Wangdung from Le, their Regimental headquarters north of the Thagla and Zangla ridges.

PLA soldiers at Wangdung

Senior Commanders (left to right) : Brigadier HS Ghuman, Cdr 11 Mtn Bde, Major General KD Mazumdar, GOC 5 Div, Brigadier Gurdial Singh, Dy GOC 5 Div, Brigadier PK Batra Cdr 77 Bde

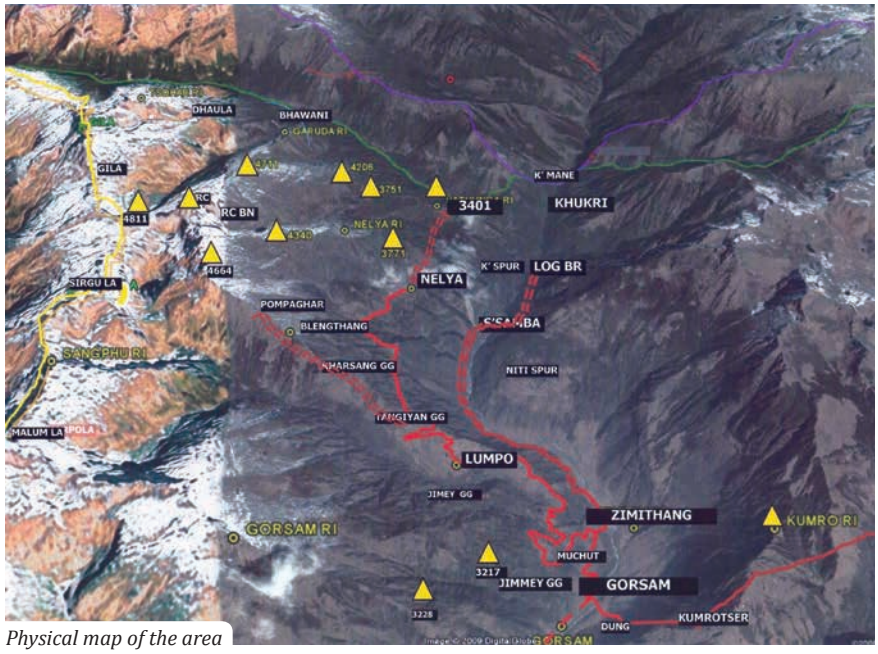
5th Infantry Division ('Ball of Fire')

The 5th Infantry Division 'Ball of Fire', was one of the very few Allied Divisions to fight three major enemy armies: Italian, German, and Japanese during World War II. '5 Div' was raised in 1939 at Secunderabad and took part in campaigns in Eritrea and Ethiopia during 1940-41, thence moving to Egypt, Cyprus and Iraq. In 1942, the Division was heavily engaged in the Western Desert Campaign and the First Battle of El Alamein.

Following the Allied reverses in South East Asia, '5 Div' were moved to that theatre and from late 1943 till the Japanese surrender in August 1945, they fought continuously from Assam through the entire length of Burma. After end of the war, they were the first unit into Singapore and were then involved in peacekeeping in Eastern Java.

Back in India, they were tasked for support to civil authority during the turbulent months leading to the partition of India in 1947. '5 Div' then detached Brigades for operations in J&K during 1947-48. In 1949, '5 Div' was re-organised by Major General Mohindar Singh Chopra who moved the formation first to Lucknow, then Jhansi and twice during 1950-51, prepared them for war as tensions arose on the western front.

After a decade in the Punjab, following the border war with China in October-November 1962, '5 Div, were operationally deployed in the NEFA (now Arunachal Pradesh) with headquarters in the Tanga Valley, where they remain half a century later.



Physical map of the area

On 27-28 August 1986, Chief of the Army Staff, General K Sundarji visited the monastery town of Tawang and was briefed by the Deputy GoC, on the situation. The Chief ordered 5 Mountain Division to move to its operational location, which resulted in 77 Brigade taking up positions to prevent further Chinese ingress in Lungrola. Rest of the Brigade, less 12 Assam moved to Lumpo, began moving on 1 September from Gachham and were concentrated by 4 September. It was in this area, 24 years earlier, on the night 19-20 October 1962 that the Chinese had attacked Indian positions on the Hathungla ridge from Thagla across the Namka Chu river.

We established our headquarters at Lumpo overlooking the Khinzemane axis (just a one man track on which even mules could not traverse). Some years earlier, in 1959, the Dalai Lama had fled from Tibet following this track to come to Gorsam, Lumla and finally to the Tawang monastery.

On 19 October 1986 morning I got orders to occupy or capture areas taken by the Chinese in 1962. On the night of 19-20 October 1986, exactly 24 years after the Chinese had attacked, we retrieved our land. "True to traditions of the Chindits, the Commander led the first column to Hathungla".


Brig PK Batra briefing Lt Gen NSI Narahari, GOC IV Corps at Nelya

After we reached Hathungla, it was a touching moment to witness some of our troops from 8 Madras and 9 Guards kneeling to kiss the ground, with the vow never to let the enemy step on our motherland because it was here that the 7th Infantry Brigade had borne the brunt of Chinese attack in October 1962. A detailed recce was carried out to site defences to beat back any counter attacks. It was a difficult task digging trenches at those heights, but the human spirit prevailed and has no limits.

However, at the highest government level there was some tension, a lurking fear of another war and we were instructed not to get into any confrontation. This was perhaps so with the Chinese as well. One day, I was visiting Lungrola pass overlooking Wangdung where the Chinese had come, and we had surrounded them, a young Chinese officer in broken English said to me, "Sir, if war here, we not fight". They were obviously scared.

The final deployment at Langrola was: 12 Assam HQ at Langrola, 'A' Coy at Pt 4527, 'B' Coy at Pt 4623, 'C' Coy at Pt 4499, 'D' Coy at Langrola including Chokyola and two PPs. In turn, the Chinese inducted additional troops and reinforced Wangdung and I remember hearing gun shots one night from their camp. Next morning their casualties were seen being evacuated by helicopter. Their intentions were still uncertain, as sometimes they opened fire with heavy machine guns towards Zangla, perhaps to show off their arsenal.

As we were now breathing down necks of the Chinese, a high level Chinese delegation came to Wangdung on 4 November for two days. On the morning of 8 November, a Chinese patrol of platoon strength was seen coming opposite B Coy at Pt 4623.The Company after giving a warning, opened fire and the Chinese stopped right there, and myths of Chinese 'invincibility' were shattered. Plans to launch a counter attack to throw the Chinese back was rejected at higher levels and the subsequent plan to capture Wangdung was not implemented for political reasons.

On 15 November 1986, the first ever official meeting in this Sector took place. The Chinese side was represented by two Regimental Commanders and three other officers including an interpreter. Own side

was represented by CO 12 Assam, Colonel JS Antal and three other officiers, both sides equipped with video cameras and audio tape-recorders. The meeting was very cordial and friendly. After claims, and counter claims, the Chinese agreed not to create trouble provided we reciprocated in kind. The Chinese Commander had come well prepared with facts and figures and narrated various treaties between the two countries, being guided and helped by an interpreter who obviously was a Political Commissar.

After some days, a strong Chinese patrol led by a Major was spotted coming down from the Thagla ridge. I happened to be at Hathungla when our patrol reported this. The CO informed me about this and I instructed him not to allow their patrol to cross the Namka Chu. There now ensued an eyeball to eyeball confrontation. Finally, the Chinese patrol which was much stronger in numbers, retreated. Next day, I was called to Corps HQs to explain this action. I explained that I had given clear orders not to allow Namka Chu to be crossed. I also explained that, it was the Chinese patrol commander who should really be taken to task for not having completed his mission, inspite of superior numbers ! Fortunately my view was appreciated while the Chinese got the message not to act aggressively.

Homage to the Hathungla Martyrs of 1962

At Hathungla, we found the sad remains of our 'Martyrs of the 1962 War', many still lying in the open, others in *sanghars*. We collected whatever remains we could and gave them befitting funeral by an all arms and services guard with buglers sounding the 'The Last Post'. Our hearts went to the brave soldiers who in spite of being ill equipped and ill prepared, fought an enemy who came well prepared , well armed and in overwhelming numerical strength in this hostile environment. It was very touching. I sent photographs of Chinese badges of rank to headquarters 5th Division. For decades, the locals had been too scared to visit the area in the belief that there were spirits of the soldiers around. However, after cremation, matters changed for the people in that revered area.

An after action report along with details/ photographs of the funeral were forwarded to the Division HQs. 77 Mountain Brigade (Chindits) were very lucky that the GOC 5 Div (Maj Gen JM Singh), IV Corps Commander (Lt Gen Narahari) and Eastern Army Commander (Lt Gen Puri) were very supportive of our actions, motivating our Brigade to maintain its high morale. I was very lucky to have three very good battalions ; 9 Guards, 8 Madras, 12 Assam plus 5 Engineer Regiment commanded by Colonel Ganeshan as part of 77 Brigade.

The Indian Army comprises highly professional and motivated soldiers, and remains in a state of 'semi-war' all the time, unlike the PLA which has not seen bullets fired in anger for much time. Our soldiers guard the borders in all types of terrain not obtaining in any other country of the world : deserts of Rajasthan, riverine plains of the Punjab, hilly terrain with snow covered mountains in the North and Northeast, marshy and riverine terrain in the East and vast coastal territories. The Indian Army has shown its mettle since 1962 on the Siachin glacier since 1984, the Kargil heights both in 1965, 1971 and 1999 wars and overseas operations in Sri Lanka. The Chinese surely realise and understand this, and also that China cannot browbeat India. It is in the interest of both countries to resolve border issues amicably in the spirit of "Give and Take", otherwise ever new Doklams and Wangdungs will keep on occurring.

(Then) Brig PK Batra with Colonel AS Antal, CO 12 Assam at Lumgrola, overlooking the Chinese Camp at Wangdung

Brig PK Batra with Major General JM Singh, GOC 5 Div in Chetak

Major General Pardeep K Batra is a war veteran of the 1965 and 1971 Wars. Commissioned into 62 Cavalry in December 1960, in the 1971 War he commanded 'A' Squadron, 45 Cavalry (PT-76s) which was awarded the Battle Honour 'Darsana' in erstwhile East Pakistan. He went on to command 45 Cavalry, 77 Mountain Brigade (Chindits) and 16 Infantry Division and retired in January 1995 as Chief of Staff XI Corps.

The Other Mirage 2000s

Deltas over Greece

"Delta-break"

Travelling some 100 kilometers north of Athens, one gets far away from this busy metropolis but close to many Greek mythology sites including Delphi's oracle. This rural area, also close to Marathonnas town where the first 42 km marathon runs took place, is home to one of Greece's major air bases, Tanagra. Here the Greek Air Force operate a wing of Mirage 2000s in the eastern flank of Greece.

Operating the French-origin air defence Dassault Mirage 2000, Tanagra and its 114thCombat Wing has a unique position in the Hellenic Air Force whose inventory of aircraft are mostly dominated by US-origin aircraft. Backbone of the Greek jet fighter force is the F-16 Fighting Falcon which is operated by most of fighter squadrons. Besides, a squadron of F-4E Phantom IIs and T-2 Buckeyes remain in service after the air force withdrew the A-7 Corsair II and RF-4E reconnaissance Phantoms.

At Tanagra, the 114th Combat Wing operates two Mirage 2000 squadrons, 331 and 332 Mira. However, each squadron has different variants of this delta-winged aircraft.

The 332 Mira flies the Mirage 2000 B/E, the other squadron, 331 Mira (also known as Ëagean *Deltas*), is equipped with the upgraded Mirage 2000-5 version.

HAF M2000EG taking off

The UAE AF with their Mirage 2000-9s train regularly with Hellenic "Deltas"

Lieutenant Colonel Vasileios Tsantilas, Deputy Commanding Officer of 331 Squadron explained that the 2000-5 version is the more modern type with a fully digital glass cockpit. The newer type differs from the B/E version in 332 Mira with its radar, armament/missiles and weapon system which is network linked. According to Lt Col Tsantilas, who earlier flew the B/E version, newer technology of the Mirage 2000-5 requires a different mindset for the pilot, with many sensors and it is essential to smartly manage them. Main mission of the squadron is air defence, for which the unit rotates its Quick Reaction Alert-QRA schedule according the country's National Defence Plan. An additional role of the squadron is precision attack for which 331 Mira is equipped with SCALP missiles (the French variant of the Storm Shadow missile).

M2000-5BG with the Tanagra hill landscape in background

M2000-5BG of 331 Mira "Aegean Deltas"

331 Mira has some 20 pilots on an average including three 'rookie' pilots engaged in operational training. Joining a Hellenic fighter squadron equipped with F-4, F-16 and Mirage 2000 aircraft, is the coveted step for a young pilot after graduating from the Hellenic Air Force Academy. Lt Col Tsantilas stated that new pilots arriving at the 114th Combat Wing are assigned to one of the two Tanagra-based squadrons, either 331 Mira (Mirage 2000-5) or 332 Mira (Mirage 2000B/E). The young pilot has to undergo an additional programme of approximately 60 sorties to be declared 'operational'. First phase includes eight sorties basically focused on learning about the aircraft itself. Although

Trio of M2000-5 of 331 Mira at Tanagra

M2000-5 in Tanagra home base shelter

it may seem simple, real time experience of taking off in a Mirage 2000 compared to a T-2 is completely different which is why the pilot needs to acquire specific skills and high quality training before moving on to the next phase.

Lt Col Tsantilas described the second phase of pilot training as a kind of 'Initial Operational Capable-IOC', followed with the same schedule and additional training before the final stage, before the pilot is declared as "Combat Ready".

331 and 332 Mira maintain strong bonds with other Mirage 2000 operators, such as the French Air Force, who has several units operational on the delta fighter. Almost every year, the two air arms meet during combined training sessions and international exercises. Regular training programmes also take place with the Air Force of the United Arab Emirates which operates Mirage 2000-9s.

Text and photos by Peter ten Berg

(photo: Frank Swinkels)

FWIT / TWIC 2019

The third-and final-phase of the 'Fighter Weapons Instructor Training' (FWIT) took place at Leeuwarden airbase during 21-31 October 2019. In this concluding 'Mission Employment' (ME) phase, all lessons learned from the previous seven months were put into practice. In the spring, this exercise started at Leeuwarden airbase with Dutch, Belgian and Portuguese pilots of the European Participating Air Forces (EPAF) in their F-16s, where the pilots are trained as weapons instructors. The FWIT course was organised by the Dutch Air Force's 322 TACTESS Squadron.

With the participation of German Typhoons, American F-15s and American

(photo: Frank Swinkels)

F-35s, FWIT pilots have practiced various forms of air combat along with Typhoons and F-15s as opponents and with the F-35s as supporting aircraft. “The FWIT is an excellent opportunity to integrate 4th generation combat aircraft such as the F-15 and the F-16 with the latest 5th generation such as the F-35”. The F-35 has very advanced sensors and cameras making this aircraft the eyes and ears of a mixed group of combat aircraft.

After the summer break, attention was focused on air-ground warfare, with various practice bombs being dropped on the nearby Vliehors range on the island of Vlieland. German Tornados were used

to disable enemy air defence systems in ‘Suppression Enemy Air Defence’ (SEAD) tactics.

In the final phase (ME), the pilots were examined for their theoretical and practical knowledge and the ones who successfully completed the task marked as ‘weapons instructors’, pinning a blue badge in their uniforms. 5 Dutch, 3 Belgian and 2 Portuguese pilots participated in the FWIT 2019.

The ‘Fighter Weapons Instructor’ is the theoretical and practical knowledge holder in a squadron. Current weapon instructors have the knowledge to optimally deploy the F-16 in coordination with other types of fighter aircraft from NATO partners, but also with other weapon systems such

EPAF Fighter Weapons School

EPAF is a collaboration between initially the Netherlands, Belgium, Norway and Denmark while the Portuguese Air Force joined the association in 2001. The EPAF was set up to jointly train F-16 weapon instructors every two years. Over the years, the focus shifted from a technically oriented weapon instruction course for the F-16, to more broadly oriented

as the E-3 AWACS, anti-aircraft systems, electronic reconnaissance aircraft like the RC -135 RivetJoint and J-STARS along with transport aircraft such as the C-130 Hercules. These weapons instructors are appropriately called 'Masters of Integration' because they have the capability to integrate all types of weapon systems into an effective combat force.

At end of the seven months course, weapon instructors in the operational squadron begin working again to train young pilots alongside coaching experienced pilots as they progress towards leadership and supervision roles.

TWIC

The FWIT also provides training courses for transport aircraft called 'Transport Weapons Instructor Course' (TWIC) involving the C-130 Hercules pilots. For a few weeks, C-130 Hercules aircraft from the Netherlands and Belgium take part in the FWIT, in which complex missions are flown together with the F-16s, these missions generally focused on providing escort to the C-130 Hercules, even while the transport aircraft completes its task. During this combined phase, a C-130 pilot can also perform the role of mission commander for the entire group of aircraft of the TWIC/FWIT. Four Dutch and two Belgian future weapons instructors participated in this year's TWIC course for various weapon systems to transfer knowledge but also to impart leadership qualities during complex air operations.

Text: Joris van Boven and Alex van Noye (photos: Joris van Boven)

‘Blue Flag 2019’

“Stronger together”

Fourth edition of the biennial exercise *Blue Flag* took place between 3-14 November 2019 at Ovda Air Base in southern Israel, the largest international air force exercise organised by the Israeli Air Force. The 2019 edition had over 1000 personnel and about 70 aircraft from various nations taking part.

“The cooperation enables high-quality international training, mutual learning and development of flight techniques and the entire package provides an opportunity to strengthen relations between countries and become stronger together” stated Tal Herman, Head of *Blue Management Team* who clearly underlined importance of the exercise.

Further, he stated, “Success factors for us are to be able to operate from one airbase, plan and debrief together and have centralised exercise management, both base ops and exercise ops. All units involved are located at Ovda.” This airbase has been operational since 1982 and is perfectly suitable for large scale exercises with close proximity to various ranges, with low level flying options and ability to simulate Surface to Air Missile (SAM) threats. It currently houses Israel’s 115th Squadron ‘Flying Dragons’ which is the dedicated aggressor unit in the Israeli Air Force operating seven F-16C ‘Barak’ fighters.

Blue Flag took place over airspace across the entire southern part of Israel. During

Luftwaffe Typhoon

Israeli F-35I ‘Adir’

Israeli F-15D ...

... and USAF F-16C

missions, the airspace was extensively available for participants with no limitations in altitude or speed, with commercial flights to the new Ramon International Airport near Eilat being re-routed during the exercise period. Flying operations were conducted with two missions a day (Sunday-Thursday) by the *Blue Forces*. Night missions were also planned. During this two week-long exercise,19 day and night sorties took place with the *Red force* providing significant challenge, the 'Reds" starting out 'easy' during the first few flights, but their tactics kept evolving as the days went by.

Apart from Israel, *Blue Flag* Air Forces also included those from the United States, Italy, Greece and Germany. This year, both the Italians and Israeli's showcased their new F-35A and F-35I 'Adir', the latter being Israel's customised variant of the F-35A Lightning II. It was a game changer with the exercise introducing a 5th generation fighter aircraft working together with F-16s, F-15s and Eurofighters typhoons.

Blue Flag was led this year by the 133rd Squadron "Knights of the Twin Tail" (operating the F-15C/D '*Baz*), which planned scenarios in cooperation with the 115th Squadron. With the 'Adir' participation in mind, scenarios had to be adjusted in order for these fourth and fifth generation aircraft to integrate and train together, each with their own missions and targets. The scenario of the exercise was based on two fictional countries *Red* (Nowhere Land) and *Blue* (Falcon State), with the Blue forces focusing on Defensive Counter Air missions during the first week to protect allied territory and then attack missions into *Red* territory during the second week.

The *Falcon Land* versus *Nowhere Land* war is centerpiece of Exercise 'Blue Flag' in which the fictional Falcon Land is made up of Germany, Italy, Greece and the United States plus Israeli Air Force squadrons. Their opponents, *Nowhere Land*, are led by the Israelis 115 Squadron, which is specifically used in exercises to mimic enemy aircraft.

As Tal Herman explained, concept of '*Blue Flag*' "the exercise is performed in two stages starting with BF1, Blue Flag week. During this stage, the participating air forces acclimatise themselves to the environment. The following stage (BF1) takes place during the second week, the participants rehearse what we call Theatre Entry and Defence Counter Air (DCA)". Herman added "During some of the sorties, the participants

Italian Air Force (Aeronautica Militare Italiana) deployed six Lockheed Martin F-35A's to Ovda

G550 'Aitam' part of 122 'The Nachshon Squadron' which also operates Gulfstream V 'Nachshon Shavit'.

C-130 Hercules for logistics support

flew against the *Flying Dragon* Squadron which simulated enemy forces, SAM batteries and MANPADS (Man-portable air-defence systems) amongst other threads to be found on the battlefield".

"During BF2, initial focus was on Small Force Employment (SFE) which was followed by a Large Force Employment (LFE) mission on 14 November. This was the most complexed scenario of *Blue Flag* with participating aircrew executing one sortie per day during the period owing to the long preparation and debriefing of each flight", said Herman.

While most large-scale military exercises across the globe are conducted with a real or fictional enemy in mind, on the other hand, an international exercise like '*Blue Flag*' does not have such scenarios. In *Blue Flag*, these are of a more generic nature including air-to-air battles, strike missions, defensive counter air exercises, suppression of enemy air defence operations (SEAD) and electronic warfare.

The next edition is planned to take place during November 2021.

Carlo Kuit & Paul Kievit/Bronco Aviation

Participants

Aircraft Type	Numbers	Unit	Air Force
F-15C/D	9	133 Squadron	Israel
F-16I	9	201 Squadron	Israel
F-35I	6	140 Squadron	Israel
F-16C/D	7	115 and 117 Squadron	Israel
G550	1	122 Squadron	Israel
Typhoon	6	TLG71	Germany
F-16C/D	4	335 Squadron	Greece
F-35A	6	13 Squadron	Italy
Typhoon	6	9, 10, 12 and 18 Squadrons	Italy
G550	1	14 Squadron	Italy
F-16C/D	12	480 Squadron	United States Air Force Europe

Exercise 'High Blaze' 2019

The annual *High Blaze* exercise took place in the north of Italy in summer 2019. During the exercise, helicopters of the Royal Netherlands Air Force of Defence Helicopter Command (DHC) practice flying in the mountains. The rugged landscapes, changeable weather conditions and difficult landing sites provide challenging conditions to operate in.

160 personnel two Eurocopter AS532 Cougar helicopters and three Boeing CH-47D Chinook helicopters were deployed to Aviano Air Base to take part in the training. Initially, there would have been five more Apache helicopters but due to an abnormality on the surface of a tail rotor blade, the Apache participation was cancelled. Around 50 vehicles and 50 containers drove to Aviano from Gilze-Rijen Air Base in The Netherlands.

Major Boudewijn Stevens, who had all responsibility for the troops, helicopters and achievement of the training objectives discussed the various objects of this exercise.

He stated, "The primary goal is to train new pilots and loadmasters in mountain flying. The pilots and loadmasters must become familiar with the environment and the challenges of flying at higher altitudes. There are also three secondary goals set starting with the training of previously qualified pilots and loadmasters, because mountain flying skills are perishable. Therefore, as many operational pilots and loadmasters as possible participate in the exercise to maintain those specific skills. The secondary aim concerns deployment and redeployment of the composite squadron. We operate here as one squadron which is composed of at least six different units. In that way, we are able to deploy almost 200 personnel dozens of trucks, containers and multiple helicopters via air and ground from Gilze-Rijen Air Base and establish our

operating base somewhere else to perform our flight operations. The last secondary exercise goal concerns the communication aspect. In a challenging mountainous environment, we check our equipment and improve our knowledge by setting up different types of connections."

The composite squadron is designed in such a way that it is as self-supporting as possible. While relying on a modular concept, the composite squadron can be tailored to specific needs. "For this exercise, we brought our own fire brigade as well as petroleum specialists to refuel the helicopters" Major Stevens said. "But we also rely on host nation support provided by the US Air Force and Italian Air Force based on Aviano. Moving so many troops and helicopters requires an extensive preparation. Therefore, we rely on 'standard operating procedures.' To verify that the described procedures are still valid and to maintain proficiency in case that a scenario requires us to deploy somewhere else, the logistic deployment is one of the secondary training goals."

The challenge for pilots is to locate landing spots in the mountains, so that is what they train for the most. There are a variety of landing types in the mountains as Captain Thijs, who is a Chinook pilot explained, "We have the pinnacle landing, which is an open part on a mountain where you can land the helicopter with all four wheels. We are looking for a spot that is as flat as possible. Then there is the ridge-line landing, which is very exacting. This incorporates landing on a ridge of the mountain with only the rear wheels on the ridge to simulate that we have a place where it is impossible for us to stand with the entire helicopter but being urgent to pick up or drop off people."

There is an individual training exposure in this exercise for every pilot and loadmaster, but the crew concept is also very important. A trainee from the loadmasters and a new pilot might fly together for some flights, or fly with an experienced pilot or loadmaster to accentuate the individual aspect more. Furthermore, the *High Blaze* exercise is focused more on the technical flight aspect instead of the tactical aspect concerning ground support in air raids and assaults.

Specifically asked about the challenges of mountain flying, Captain Thijs replied "In the Netherlands or in Germany when

we train, we usually fly low level at a maximum height of around 2,000 feet. Here we sometimes fly up to 10,000 feet where the air is thinner and you can easily feel a difference in the controls. You have to be able to steer the helicopter. The performance of the helicopter simply decreases. Usually, we are limited in the amount of power that we can use as a load on the transmissions, in the mountains, we are more limited by the engines because they reach maximum temperatures which we do not want to exceed, so we can get less power out of the engine. This means that we have lower loads but we also have to change the way we approach."

For Captain Thijs, this is not the first *High Blaze* exercise, but the first time training these procedures and landings at night. "That makes it even more complicated. In the Netherlands, when we fly at night with night vision goggles, we often have residual light from cities. What the goggles need is a little bit of light to enhance, so residual light from a city, or a freeway, all helps. But in the mountains there are places with no artificial or natural light, which is really imposing. The infrared searchlight is used to light such areas."

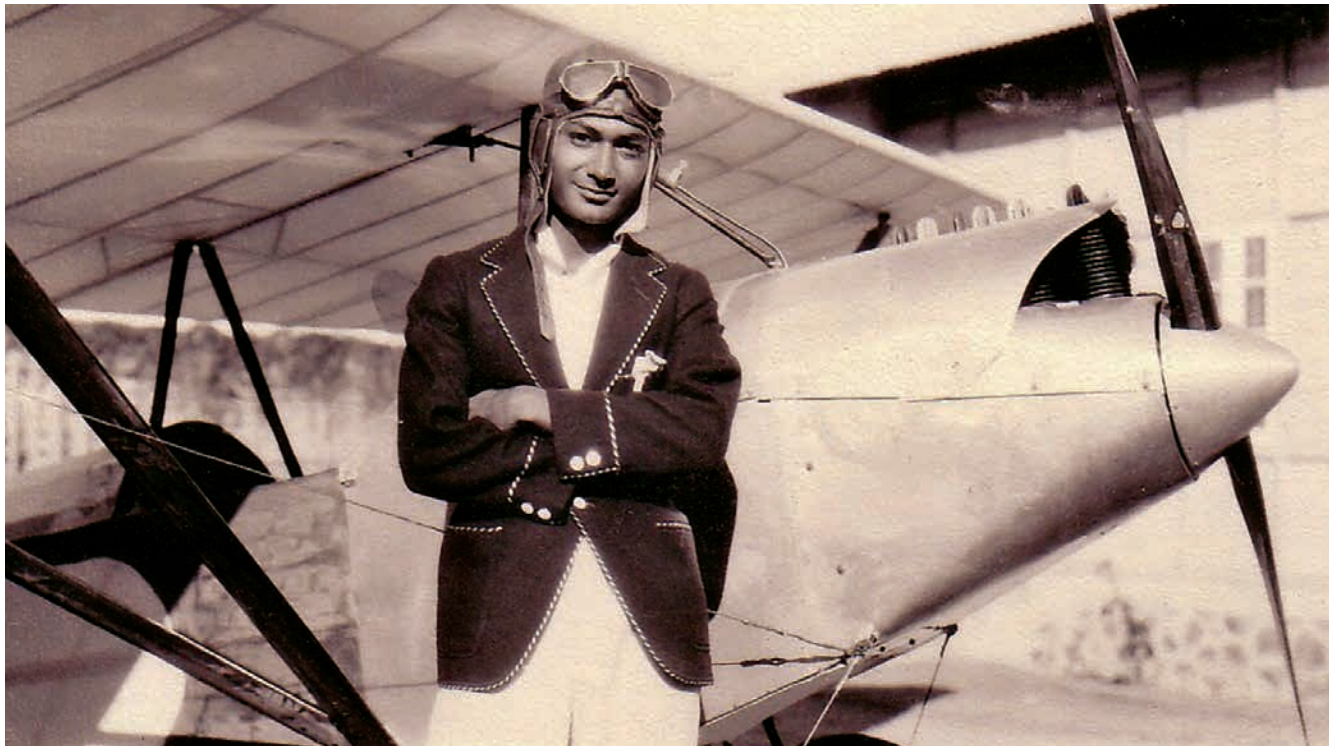
A typical *High Blaze* sortie starts with a map study, coordination with other crews concerning the intended training areas and establishing a communication plan with frequencies to communicate with each other and with ground personnel. After this, there will be a crew brief and then the crew go to the helicopters. When the pre-flight checks are performed, the helicopters start-up and take-off heading towards the mountains. The flight to the designated areas takes 20 to 30 minutes. When the often unpredictable weather is confirmed and a recce pass is executed, they begin the first landing.

Captain Thijs clearly enjoyed the exercise: "This is the cherry on the cake for all of us!" Major Stevens was also happy, for different reasons. "The results of the exercise were great. We were able to perform 95 percent of the flights that we had planned. That is an exceedingly high realisation percentage which says something about the deployability of the helicopters, but more importantly that the maintenance support is carried out in an effective and efficient manner. To achieve that as a detachment is something we are very proud of."

Article and photos:
Jeroen van Veenendaal

India's Aviation Pioneer

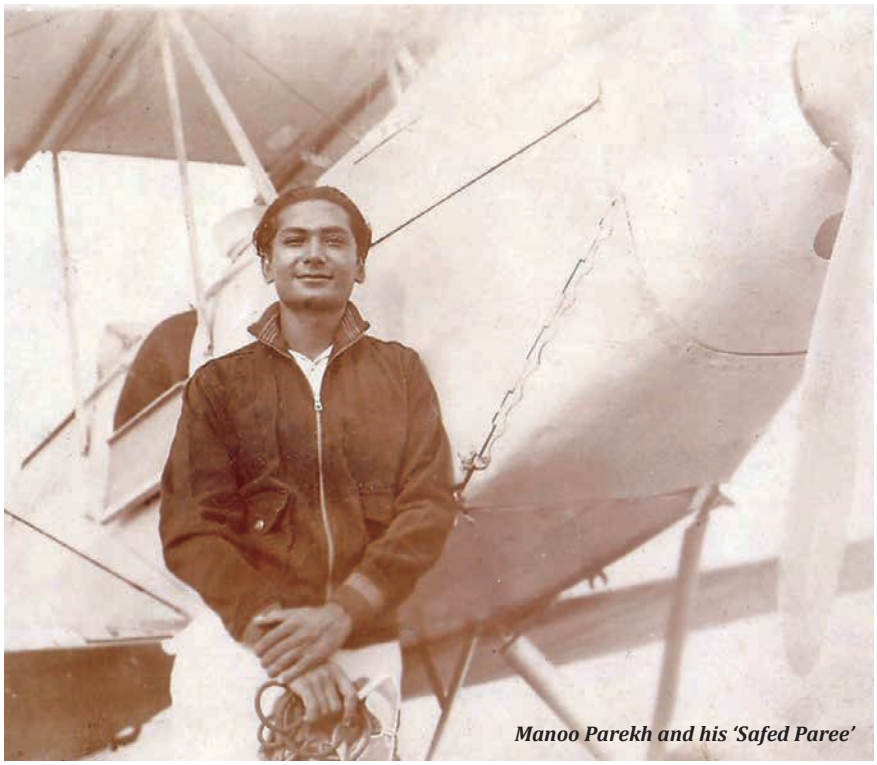
Manoo Parekh (1911–1983)



It's hard to believe that Manoo Parekh, born in 1911, a jeweller's son from Jamnagar in Gujarat, gave up his family business to get into aviation as early as in 1931, even before the Indian Air Force was established.

Having a scientific bent of mind, he first invented a peanut shelling machine in 1929 for which he was given a Gold Medal but his passion was in aeroplanes. He purchased magazines like *Popular Science* and *Popular Mechanics* from where he imbibed plans to build an actual aircraft! He started off by collecting bicycle wheels, pipes, wires and fabric but later had to import the engine and propeller from the UK.

Having then constructed an aeroplane, at a total cost of some Rs 5000, he didn't know how to fly it! He requested many trained pilots to flight test his aeroplane but they were apprehensive about of this homemade airplane which he called *Safed Paree* ('White Angel'). Yet, Manoo didn't give up. Finally a British pilot, after a complete check, agreed to test fly it, which



Manoo Parekh and his 'Safed Paree'

he did and later exclaimed that it was "a very gentle baby to fly" !

During those days in India, there was no certification authority and so Manoo's pilot's license was given by the British. Manoo's father Uttamchand then sent him to the Karachi Aero Club for continuing his flying training, and this was where he met the legendry JRD Tata and earned his 'B' licence.

All this while, even as he was carrying out flying, he remained a *Gandhiwadi*, following the nationalist leadership of Mohandas Karamchand Gandhi. Manoo had a Bell & Howell 16mm camera with which he continuously recorded many historical events over the years 1928 to 1932 which involved India's freedom struggle. Mahatma Gandhi, Sarhadi Gandhi, Subhash Chandra Bose, Saudamini Deshmukh, all of them were recorded for posterity in his films. Major events covered by him included were the Salt Satyagrah, a procession of Shaheed Bhagat Singh and the Indian National Congress meeting at Karachi in 1928.

Teaching both RAF and RIAF pilots during WW-II

Another interesting event was when he was flying reels of India's first motion picture 'Sayandhri' from Karachi to Bombay. Owing to a technical fault, he and his co-pilot Gadgil force-landed at an open field near Vasavad in Gujarat. After carrying out repairs, they started the engine but the loud sound obviously greatly annoyed a nearby bull which then charged the aeroplane and severely damaged it. The angry bull tossed the aeroplane into the river and after its recovery, it was unceremoniously recovered from the river tied on a bullock cart! For posterity it must be recorded that the aircraft was registered as VT- ADU.

The Jamsaheb of Jamnagar, supported by his brother Himmat Singh were impressed by Manoo Bhai whom they sponsored to the UK for receiving a commercial pilot license. They were not only royalty but accomplished cricketers, playing in the Ranji and Duleep Trophies. Aviator Manoo would often fly them from Jamnagar to Karachi from where

Bullock power "rescuing" Manoo's aeroplane from the river

A dapper Manoo Parekh with his aeroplane

they would take an international flight to England to play test cricket.

Aviator Manoobhai continued his aviation career which included flying for the King of Malaya. Then came World War II, during which time he imparted flying training to both RAF and IAF pilots. Even though he was a professed Gandhian, the British never arrested him possibly as he was very useful for the defence of India during the War. Did he therefore miss being given the *Freedom Fighter* status since the British never jailed him?

During the turbulent months preceding partition of India in 1947, the Jamsaheb of Jamnagar asked Manoobhai to create an independent *Kathiwari Air Force* but he refused and Sardar Patel requested him not to do any such thing but "Go for One India". He also flew refugees from Multan in Pakistan to India without any charge.

In 1955, even though he had lost his flying licence owing to poor eyesight, continued to retain his hanger No.10A at Juhu Airport in Bombay. In 1962, he applied for an IOC petrol pump in lieu of his hanger which was opposite the Esso multinational oil company. Of the 427 applications submitted, he got the petrol pump on a prized half acre plot in 1962. Later, his son Jitoo was to open the very first CNG dispensing unit in Bombay in March 1993 which was a huge success, the CNG gas at that time being disbursed at Rs. 9.71 per kilo.

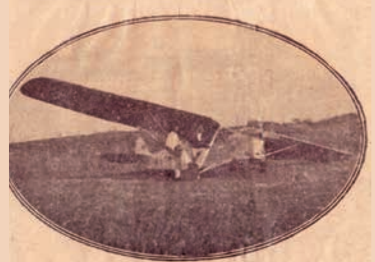
Manoobhai Uttamchand Parekh passed away in February 1983, an unknown aviation hero as the Gujarati's of Bombay and Jamnagar had forgotten him and his pioneering aviation activities which went into oblivion. Till now that is!

Article and images from Jitoo Parekh, son of Manoo Parekh B.FA (Cinema), Concordia, Canada

Celebrating 100 years of flying in India, on 16 December 2003 Manoo's photo was proudly displayed at the Nehru Science Centre in Worli, Mumbai.

Clippings from the past

LATE NEWS SUPPLEMENT. October 22, 1933.



A FORCED LANDING.—The pilots of this aeroplane, Messrs. N. G. Gadgil and M. V. Parekh, had some exciting adventures, while flying over Vanavad. They first had to make a forced landing owing to a defect, and just as they were taking off, a bull charged the machine, and did considerable damage. The 'plane was carrying the film "Sairandhree" to Bombay.—Photo, M. U. P.

Tribute to Nawab of Pataudi

Bradman, Still a Power

Prince Duleep Sinhji Interviewed

KARACHI, Tuesday.

Looking a bit but considerably picked up in health as a result of his sixty-six days' stay in India, it was a cheerful "Duleep" that greeted a "Sind Observer" representative in a secluded lawn of the Carlton Hotel this evening.

Wearing his usual 'infectious smile' his first query was about the latest Test match score.

"This time I have nothing to give you. I enjoyed my stay at Jamnagar and am back to England to resume my treatment which had suddenly to be interrupted," he said.

Accompanied by his elder brother R. K. Himmatsinhji, Prince Duleep Sinhji flew this morning in a 'plane piloted by Mr. M. U. Parekh, a native of Jamnagar, a Puss Moth belonging to the Karachi Flying Club. The 'plane took off at 6-30 a.m. and landed at Drigh Road at 9-45 a.m. The journey was performed through cloudy weather and rain [illegible].

"Duleep" had instructed the Manager of the Hotel that nobody should disturb him and that was one of the reasons why he preferred the seclusion of Carlton Hotel to the bustle of Khijarey.

"So you missed the first Test. I hope you would be at the Lord's," said the "Sind Observer" representative.

"Oh, that does not worry me", said the Prince.

"Do you feel like playing cricket?" was the next question.

"I have to begin at the beginning and to rebuild my reputation. No, I have not handled a bat of late. My first concern is my health," he said.

Prince Duleep Sinhji was glad that his prophecy about the inclusion of the Nawab of Pataudi in the Test eleven had been fulfilled. Though Pataudi did not fare well in England's first innings, Duleep was optimistic about his being selected for the subsequent Tests.

"He is in the peak of form now. After all a player cannot be piling runs all the time. Otherwise cricket won't be cricket," he said.

Asked about Don Bradman's eclipse, the Prince was of the opinion that Bradman was still a top-scorer and his wonderful match in England and another match in which he collected over a hundred showed that he was still the wizard of the willow.

"Apparently, fast bowling is troubling him as it has troubled several others," he remarked.

K. K. Duleep Sinhji has an idea of returning to India to Nawanagar for a longer stay.

"Would you help your brother in the administration of the State?", asked the reporter.

"You must ask my brother," he replied smiling.

The Prince was very enthusiastic about the proposal to have a cricket club of India in Bombay. A permanent ground like the Lord's in England where Test matches could be staged was absolutely necessary and Bombay which was the home of Indian cricket was pre-eminently suited as the venue for erecting a permanent structure. He was glad that Lord Brabourne was taking a keen interest in the matter.

The Prince is flying to England by the Imperial Airways to-morrow morning.

PLANE CARRYING FILM FORCED TO LAND

Information has been received by the Bombay Flying Club that a Moth 'plane of the Karachi Flying Club, which left on Friday afternoon for Bombay, carrying the first Indian multi-coloured talkie "Sairandhree" has had a forced landing at Gondal, Kathiawar, as the machine suddenly went out of order.

It appears that Messrs. N. G. Gadgil and M. U. Parekh, who piloted the plane thought it advisable to land at that place as it was risky to proceed further.

On receipt of information, Mr. A. C. Patel of Messrs. Patel Brothers flew to Gondal on Saturday and returned to Bombay with the film on Sunday morning. The talkie belongs to the Famous Pictures Company, Bombay.

The Moth plane will leave for Karachi shortly.

(*Earlier news on page 22.*)

INDIAN AVIATORS AT JUBBULPORE

JUBBULPORE, Feb. 15.

Messrs. M. V. Parekh and C. B. Bess, two Indian aviators, working with the Laxmi Flying Club of Karachi, arrived here yesterday afternoon in their two-seater Moth plane V T A A Y., after covering nearly 1,500 miles in 17 hours, and landed at the aerodrome at Khamaria, about 7 miles out from here.

The young men were practically stranded, but Mr. D'Costa of the C P police motored down, and took them over to the bungalow of Mr. Mahadeo Singh.

A large number of people proceeded to the aerodrome, and partook of free joy rides. These enterprising young lads are the first Indians to pilot a plane out here.

Aged 9 and 21 respectively, they left Karachi at 7-30 a.m. on the 7th, and arrived Bombay at 5 p.m. leaving Bombay on February 10, at 9 a.m. they reached Khandwa at 2 p.m. and left at 8-30 a.m. on February 12 arriving here at 12-15 noon.—United Press.

KARACHI-JAMNAGAR FLIGHT

Gujarati Aviator's Aerial Trip

KARACHI, Wednesday.

—A Karachi aviator's excursion in the course of his training to Jamnagar in an aeroplane throws an interesting light on the possibilities of development of commercial aviation between Karachi and Cutch and Kathiawar.

The aviator is Mr. M. U. Parekh, at present a pupil of the Karachi Aero Club who, the *Sind Observer* understands, had a successful aerial trip to and from Jamnagar during the week-end.

He left Karachi at noon on Saturday and reached Jamnagar at about 6 in the evening. In between, he halted at a place in Cutch and had a stay there for about an hour and a half.

He returned to Karachi the next day.

In his trip, Mr. Parekh was accompanied by another local aviator, Mr. Gadgil.

The distance between Karachi and Jamnagar is about 260 miles and the actual time taken by the Karachi Aero Club's machine in which the trip was made, was three hours and forty five minutes.

The time required to reach Cutch would be two hours at the outside.

Ordinarily by railway route, it takes about three days to travel between Karachi and Cutch. Travel by aeroplanes would reduce this time to less than as many hours.

The time required to reach Jamnagar from Karachi is not less than 60 hours. By aeroplanes one can reach there in three or four hours.

IS BRIGHTEST STAR IN TERRA FIRMAMENT

First air mail between Bombay and Kathiawar was met on arrival at Jamnagar Aerodrome by Mr. M. U. Parekh in Hillman '14.' Mr. Parekh is Manager of Coronation Motors, progressive Distributors for Kathiawar; himself qualified pilot, has logged over 700 solo flying hours in own D.H. Moth.

* * * * *

La première Poste Aérienne entre Bombay et Kathiawar a été accueillie à son arrivée à l'aérodrome de Jamnagar par M. M. U. Parekh dans une '14' Hillman. M. Parekh est le Gérant de la maison Coronation Motors, Concessionnaires progressifs pour Kathiawar; il est lui-même pilote certifié et a enregistré plus de 700 heures de vol solo dans son D. H. Moth.

Die erste Luftpost zwischen Bombay und Kathiawar wurde bei Ankunft auf dem Flugfeld von Jamnagar durch Herrn M. U. Parekh in einem Hillman '14' empfangen. Herr Parekh ist Leiter der Firma Coronation Motors, die fortschrittlichen Vertriebsunternehmer für Kathiawar. Er ist selbst qualifizierter Flieger und hat mehr denn 700 Solo-Flugstunden in seinem eigenen D.H. Moth zu seinen Gunsten.

* * * * *

El primer Correo Aéreo entre Bombay y Kathiawar fué acogido a su llegada al aeródromo de Jamnagar por el Sr. Don M. U. Parekh en un auto Hillman '14.' El Sr. Parekh es Gerente de la casa Coronation Motors, Concesionarios progresivos para Kathiawar; él mismo es piloto competente y ha registrado más de 700 horas de vuelo solo en su propio D. H. Moth.

JIBAGE.

An Indian Aeroplane-Builder.

Mr. M. V. Parekh of Jamnagar, Kathiawar, who has constructed an aeroplane with a flying capacity of 90 miles per hour. All the parts were constructed here, with the exception of the engine and the propeller which are of American make.

એરોપ્લેન બનાવનાર હીંદુ જવાન.

જામનગર કાઠીયાવાડના આ હીંદુ રહીશ મી૦ એમ. વી. પારેખે કલાકના ૯૦ માઈલ ઉડી શકે તેવું એરોપ્લેન આખું આ દેશમાં બનાવ્યું છે. આ વીમાનના બધા ભાગો અહીંજ બનાવ્યા હતા, પણ એનજીન તથા પ્રોપેલર અમેરીકન બનાવટનાં છે.

Mon Dieu!

The World's Largest Private Collection of Fighters

A French winemaker has the distinction of having the largest private collection of fighter jets in the world. Michel Pont, a vintner who lives in the Burgundy region of France, grows grapes for wine but collects fighter jets for passion! Pont's collection includes aircraft from dawn of the jet age, such as the first gen British Meteor fighter and onwards till the fourth gen F-16 Fighting Falcon.

Pont, a former race car driver, bought 12 hectares (29 acres) in the heart of the French wine country, the property including a castle built in 1340. The surrounding land originally wasn't worth much, but after clearing it Pont set aside four hectares for vine cultivation and two to three hectares for his airplanes: he had his priorities straight from the beginning.

Pont now has 110 aircraft, mostly fighters but including a handful of military helicopters. His collection is diverse. Chronologically it starts with the Gloster Meteor, the UK's first fighter jet and the only Allied fighter jet to serve in combat during World War II. Next is a F-86 Sabre in Luftwaffe markings, which served West Germany in the 1950s. Then there are a whole lot of fighters from the '60s and '70s, including the Lockheed F-104 Starfighter, English Electric Lightning, F-100 Super Sabre and Mirage III fighters.

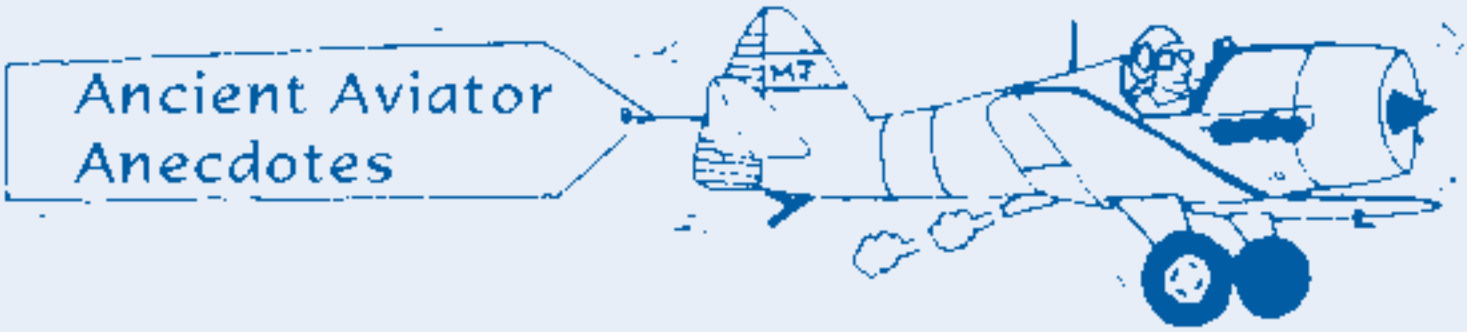
The collection has some special types too: a Republic F-105 Thunderchief, one of the largest fighters ever to serve with the US. Air Force and workhorse of the Vietnam war, is in the collection. There are several fighters from the former Soviet Union, including a Sukhoi Su-7 *Fitter* ground attack aircraft and several MiG-21 *Fishbed* fighters, purchased from former Warsaw Pact countries like Poland and Hungary. One unidentified aircraft was purchased from Djibouti.

The most modern—and thus difficult to procure—fighter in Pont's inventory is a F-16A Fighting Falcon fighter. According to Pont, he was friend with a Belgian Air Force general and expressed an interest in acquiring a Belgian F-16. Unfortunately the US typically gets final say on how American-made equipment is disposed of, even by its closest allies, and for a long time the answer from the Belgium Air Force was a sympathetic "no", but Pont eventually got his fighter !

Pont's collection has received the stamp of approval by the Guinness Book of World Records. Unfortunately, it's getting harder than ever to amass collections of military equipment such as these. Older aircraft, particularly those operated by foreign countries, are easier but more modern US. Air Force and Navy aircraft are difficult, if not impossible, for private collectors to obtain. Although the earlier model F/A-18C Hornet no longer flies on active duty, concerns about technology transfers and parts making their way onto the international black market means that it is hard to private collectors getting their hands on this one.

Pont's castle at Savigny-lès-Beaune, along with his fighter jet collection is open every day from 9 a.m. to 12 p.m. and from 2 p.m. to 5:30 p.m.

Courtesy: Kyle Mizokami, Popular Mechanics



Air Vice Marshal Cecil Parker recollects....

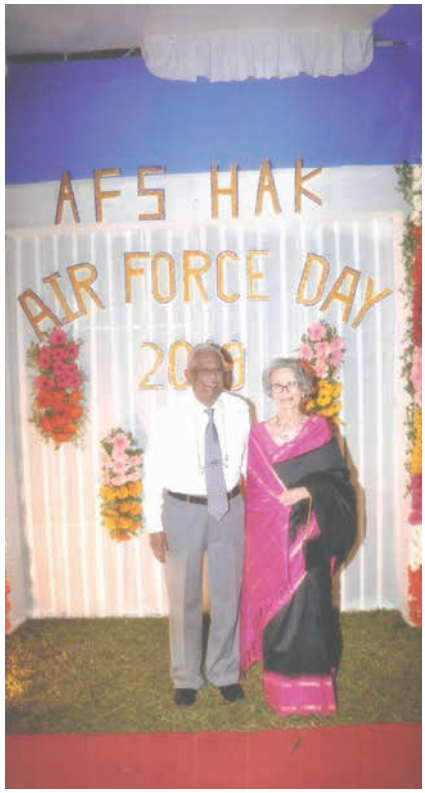
A Haven in Hyderabad

The Air Force Officers Co-operative Housing Society (AFOCHS) at Vayupuri in Hyderabad came into being on 8 January, 1963. The (then) Andhra Pradesh Government had allotted 50 acres of land (adjacent to and south of Sainikpuri) to the Society at market rates. The land was allotted to provide affordable housing plots to officers of the defence forces. In the mid–sixties, landscaping and development took place and 210 plots were created. The layout ensured wide roads, adequate greenery and prohibited multi-storied buildings or flats in the residential zone. Gradually air force/defence officers purchased plots and commenced building the first generation of houses.

In the early 1970s, at the request of my recently widowed mother, we sold our family property in Madhya Pradesh. In 1975, I was posted to command the air base in Hakimpet, a short distance from the housing colonies in Vayupuri / Sainikpuri / Defence Colony. I was in need of a plot to build our house and Hyderabad was eminently suitable as we had both personal and professional links with the city. We acquired a plot in Vayupuri and in 1976 'Parkhaven' was built. For the next 13 years it was rented out while I completed my innings in the air force and a post–IAF retirement assignment in the corporate world in Mumbai. Since 1990 we have resided in 'Parkhaven', so named, partly for its proximity to West Park (*see image*), partly for the name of its owner but primarily for its future role as our retirement harbour after having led a very nomadic life.

In the 56 years of its existence, Vayupuri has grown extensively. Of its 210 plots, only eight remain 'open', while 202 houses have been built of which 100 were owned / occupied by defence officers / widows, while 102 are owned / occupied by non-defence civilians. The cost of land has escalated and very few defence officers can now afford to purchase plots there. In fact most prefer to buy flats in gated colonies, this being more cost-effective and convenient. Over the years, architecturally, the first generation of houses have developed a distinct 'character' of their own. These houses are very gradually giving way to three-storied, steel and glass 'designer' homes of the new owners. A similar change is visible in our adjoining colonies.

'Parkhaven' is now 43 years old and now for 30 years we continue to enjoy a most comfortable retired life. For the first ten years I was in the academic world but had the privilege of working from home. Among our residents is the son of a founder-member air veteran whose generous donation has given Vayupuri an international class indoor badminton court. Another generous donation from the seniormost surviving, plot-owning resident (a nonagenarian) has created a club house which abuts a new swimming pool. Community activities range from annual celebrations of Independence / Republic / Founders Day to monthly get-togethers. Our quiet, clean and open colony is not only a magnet for early morning / evening



The Ancient Aviator with (the young) Shirley Parker

walkers from adjoining colonies, but has won many awards / certificates in a very productive tenure of our present President.

A few days ago, my pilots course (No. 58 PC) marked its 67th anniversary. Of the 30 of us young pilot officers who were commissioned at nearby Begumpet on 30 August, 1952, ten are very much alive (and kicking!) ranging in age from 87 to 90 years. While six reside in the NCR and two are in Australia, two of us retired in Vayupuri and Sainikpuri. We two, along with coursemate's widows, families and children celebrated our course anniversary with a Luncheon getogether at 'Parkhaven' Vayupuri.

The Char Minar(s) of Hyderabad

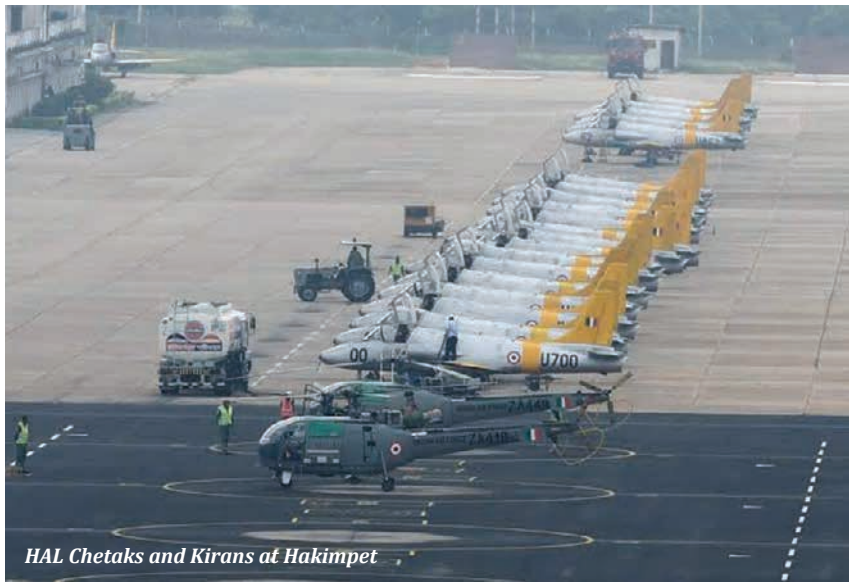
Hyderabad's iconic Charminar is almost as well known as is its biryani. Not as is well known is that the city is also home to our air force's *char minars* of learning. These four foundational training establishments are located at the air bases at Begumpet, Hakimpet, Dundigal and the CAW (College of Air Warfare) in Secunderabad. In 1951 No. 1 AFA (Air Force Academy) was relocated from Ambala to Hyderabad. Basic and Advanced stages of flying training moved to Begumpet with Tiger Moth and Harvard IIB respectively while Applied stage (Spitfire and Tempest) moved to Hakimpet. CAW was established in 1959 while the permanent AFA was set up at Dundigal in 1973. I had a personal link with all four of these training instituitions.

Most of my flight cadet training period of 18 months were spent at Begumpet. Of the 50 of us who commenced pilot training at Ambala, 30 won their wings and were commissioned as pilot officers by Air Vice Marshal Subroto Mukherjee (then DCAS) on 30 August, 1952. Our graduation was a fairly simple ceremony on the flight tarmac of Begumpet in the presence of a small gathering which included my parents and a specially invited young lady (now my wife of near 64 years). With the setting-up of the AFA, the basic stage of flying training moved there while the advanced stage relocated to Hakimpet. Begumpet now houses the NSS (Navigator & Signaller School) with Avro 748s.

In 1969, as a wing commander, I was detailed to attend a six–week training course at the CAW. Consequent to the

HAL Kirans over the AFA Dundigal

HAL-HS 748s at Begumpet



HAL Chetaks and Kirans at Hakimpet

In 1975, as a group captain, I returned to command FTW (Fighter Training Wing) at Hakimpet. It was a great professional education to induct 50 new Polish jet trainers (the Iskra) into our air force, oversee the advanced stage of pilot training on both Iskra and Kiran aircraft, rotary wing training at HTS (Helicopter Training School) and controller training at ATCOTE (Air Traffic Control Officers Training Establishment) : very few Station Commanders / AOCs have has 84 aircraft on base! Today Hakimpet continues pilot training on both Kirans and Chetaks helicopter and this year deservedly received the Presidents Colours.

In 1983, as an Air Vice Marshal, I was posted as Commandant of the AFA. At that point of time, our air force had no basic trainer as the HT-2 had been phased out and the HPT-32 was still two years away. My primary task was to oversee the IAF's very first attempt at direct basic flying training on Kiran jet trainers. This was an expensive exercise and we had to seek a balance between an acceptable attrition rate while maintaining strict training standards. In addition, we had all officer branch training (except technical) at the AFA together with a rather splendid GP (Graduation Parade) twice a year. Today the AFA operates the Pilatus PC-7 basic trainer for Stage I pilot training.

Nearly all IAF officers (and many foreign ones too) have passed through these portals of learning where skills and knowledge take root in the Human Resource element of India's military air power.

I left the Air Force 33 years ago but, having settled in Hyderabad, have the pleasure of receiving an invitation to Air Force Day celebrations from each of the IAF's *Char Minar's* of learning while this enables us to participate and renew memories every October.

feedback requested by the faculty, CAW was happy to accept and implement most of my recommendations pertaining to syllabus content and presentation thereof. I was pleasantly surprised and privileged to receive a letter of appreciation from the Commandant. This year, CAW marked it's Diamond Jubilee.

My four–month stay at CTU (Conversion Training Unit) at Hakimpet is remembered primarily for my bale-out from a blazing Tempest on 28 October 1952. Following a series of engine failures, this aircraft type was grounded and we moved to our very first jet squadrons.

Pilatus PC-7s on the Dundigal flight line

25 Years Back

From Vayu Aerospace Review Issue I/1995

Washington's view on South Asia

Visiting India on 12 January 1995, the US Secretary for Defence Mr William J Perry has stated that ending of the Cold War (has) opened a new era in (the) United States-India security relations. "Old barriers to our cooperation have been replaced by new opportunities. We in the United States are excited by these opportunities and want to increase the security links between our two democratic nations. Doing so will allow us to better pursue our common security interests and provide a base of understanding for working out differences".

First USAF C-17 squadron operational

Air Mobility Command (US Air Force), has declared 17th Airlift Squadron at Charleston AFB, South Carolina, equipped with 13 McDonnell Douglas C-17 Globemaster IIIs as fully operational. Later in 1995 a C-17 will undertake circumnavigation of the globe during which it will re-enact a flight across the Himalayas to commemorate the operations flown during the Second World War 'over the Hump' between India and China.

Taiwan and Qatar buy Mirage 2000-5

Following purchase by Taiwan of the multirole Mirage 2000-5, Qatar will also purchase Mirage 2000-5 aircraft. Chosen for both its operational qualities and its performance, the Mirage 2000-5 is equipped with the RDY radar made by Thomson-CSF and the Snenma M53-P2 engine and armed with the Matra Mica and Magic 2 missiles.

Pakistan considers the JAS 39 Gripen

Following the US *volte face* on its F-16 deal, the Pakistan government is now considering the Swedish JAS 39 Gripen as a possible replacement. According to reports, the Pakistani government has already sent a letter of intent for 60 Gripens to Sweden, and intends to shortly follow it up with an operational evaluation of the type.

New SAMs for Pakistan

The Anza Mk.II, an all weather weapon system with a range of over 6000 metres has been developed at the Dr Abdul Quadeer Khan Laboratories in Pakistan. The portable anti-aircraft missile has proved to be more than 95% accurate in field trails and was recently handed over to the Pakistan army which already has the Anza Mk.1 as well as Stinger missiles.

An Australian AJT

Aircraft types shortlisted for the Royal Australian Air Force Lead-in Fighter Trainer Programme (LIFT) have now been shortlisted to six comprising the Aermacchi MB-330FD, Aero L-59,, Alenia AMX-T, BAe Hawk 100, Dassault Alphajet and MDC T-45 Goshawk. Between 35 and 45 aircraft will be acquired to replace MB-326Hs in the training role with first deliveries planned from June 1999.

Indonesia orders Hawk

Indonesia plans to procure over $2 billion worth of military equipment including a follow-on-order for 20 Hawk 100/200s. In FY 1998/99 it aims to allocate $ 116.5 million for acquisition of a further five Lockheed F-16A/Bs and $60 million for two new in-flight refueling tankers to replace the elderly KC-130Bs currently in use. The plan also includes 16 UH-60 Black Hawks in FY 1995/96 and 16 training helicopters in FY 1998/99.

K-8s and Agosta 90Bs for Pakistan

The Pakistan Air Force has recently received six Karamkoran-8 (K-8) aircraft co-designed and developed with the Chinese to be used as advanced jet trainers, and eventually to replace the Cessna T-37s in service. The Pakistan Navy is also to purchase three French Agosta 90B diesel-electric submarines, the first of which will be delivered by the year 2000. While one submarine is to be built by the French, the other two, as part of a technology transfer agreement will be assembled in Pakistan.

Indian Naval Aviation awards

INAS312, flying Tupolev Tu-142Ms have been awarded the Chief of Naval Staff Trophy for Flight Safety and also adjudged as the best Naval Air Squadron overall. INAS 310, flying Dornier 228s stood second and INAS 561, the helicopter training squadron at INS *Rajali* was adjudged the Best Training Squadron.

Appointments

Air Marshal AY Tipnis

Air Marshal AY Tipnis has been appointed as Senior Air Staff Officer, Western Air Command. He was commissioned as a fighter pilot in May 1960 and has logged 3,400 hrs on various types of aircraft. During his career, he has held many important command and staff appointments, including project in-charge of the Mirage 2000 induction. He was ACAS (Inspection) at Air Headquarters, has also been on deputation to the Government of Iraq for instructional duties.

Director of Aeronautics

Mr Ajay Kumar has been appointed Director of Aeronautics (R&D) and Secretary, Aeronautics Research & Development Board (AR&DB) in the Ministry of Defence at New Delhi. He has specialised in Aero Gas Turbines and project management funding and has been actively involved in staff functions including monitoring of major projects including the LCA, Kaveri and unmanned vehicles.

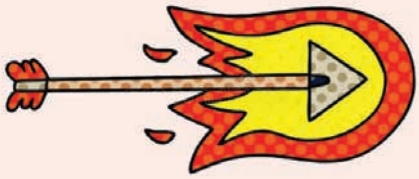
Tale Spin

Tick-Tock

Before a *Middle Kingdom*-based company created TikTok, this short lip-sync video app in 2012, the Swiss had their cuckoo clocks going Tick-Tock since the *Middle Ages*. Lo, the Swiss flag today is a red square with a white cross while the Chinese have their red flag with five golden stars. The Gnomes of Zurich meanwhile remain the keepers of much wealth, be it in Francs or Yuan, funding varying shapes in international skies.

You have a choice : the A320 or C919 ?

Nuclear Arrows, Hydrogen Chakras



A very senior government functionary of an eastern state while inaugurating a science fair, referred to key characters of Indian mythology wielding nuclear-powered arrows as also flying saucers with hydrogen energy. The scientific fraternity immediately questioned the sanity (of the person) and sanctity (of the function).

From the Asian Age

But, ours not to reason why !

Babugiri to be replaced by AI ?

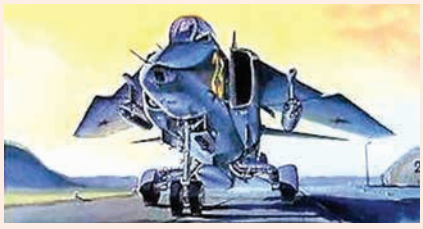
To break their long-suffered logjam, Indonesia's President has ordered his Government to remove two ranks of public servants (read bureaucrats) in 2020 and replace them with artificial intelligence (AI), "so as to cut red tape which hampers investment". Such transformation would improve the business climate by obviating dozens of overlapping rules and cutting red tape.

Wow ! Imagine what employment of AI would have contributed to in our MMRCA imbroglio.

Wanna be like you !

Reporting phase out of the last MiG-27 from the Indian Air Force, a leading, highly respectable newspaper, illustrated the news item with a drawing of the Rafale, the first of which new generation Omni role fighter will only arrive in India in mid-2020.

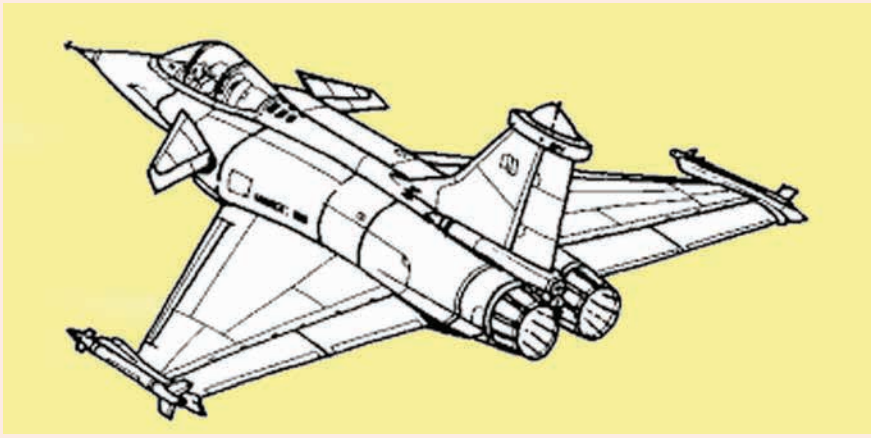
Only two generations apart !



Hyundai's electric air taxi

The South Korean's have done it again ! The US cab-calling company Uber have teamed with Hyundai Motor to develop electric air taxis so as to introduce small self-piloted cars for easing the maddening urban congestion. Global players like Germany's Daimler, China's Geely Automobile and Japan's Toyota have all unveiled investments in startups that aim to deploy electric flying cars capable of vertical takeoff and landing. Obviously, there are big technological and regulatory hurdles ahead but *moja* off to the Koreans !

모자



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