VAYU

Aerospace & Defence Review

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Tejas LCA attains IOC

The M-MRCA stakes

Fifth generation jet fighters

Air Dominance

Arming the M-MRCA

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Cover : The Tejas LCA limited series production–2 (KH-2012), fitted with a pair of R-73 CCMs (photo from National Flight Test Centre)

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Flying in the face of facts

The operational flight of the Tejas, the indigenous Light Combat Aircraft, has been met with muted applause. New Delhi flags off the same 'Made in India' piece of defence equipment again and again. Every defence minister has declared the Arjun tank ready for deployment. The Tejas has passed its initial operational clearance and will hope to receive final operational clearance in the next 18 months. Even after that, much of its avionics and electronics will still have to be sorted out. The expectation is that it will be a pillar of the military system only a decade more from now. Another source of cynicism is the fact that chunks of the Tejas, including the engine, are imported.

There are many sound arguments as to why India should be spending billions to develop a Tejas fighter, an Arjun tank and a host of variously named missiles. They are not, however, the ones that are being touted in public. Self-reliance in defence, in the sense of being able to wholly manufacture all the key defence platforms, is a myth. It is simply impossible to master all the components and technologies, let alone pay for the research and development costs, of even a single fighter airplane. Even the US imports bits and pieces of its arsenal. Self-reliance in defence needs to be redefined. What it should mean is the development of homegrown manufacturing and technological abilities that ensure that India can be an essential part of various global defence supply chains. It is important that these capacities should have both civilian and defence spin-offs.

Self-reliance also means to be able to use diplomacy to become embedded in global security arrangements that ensure that no country will be in a position to sanction or deny India essential defence equipment. Both of these are feasible thanks to India's present economic stature. But they can only be accomplished if a mindset that treats foreign firms as a necessary evil and gives lip service to private Indian manufacturers is done away with. This will not be easy — the ministry of defence is seen as among New Delhi's more fossilised bureaucracies. India's defence equipment capability should be measured in terms of the quality of its machine tools industry, its precision engineering capability and its ability to generate the sort of software that lies at the heart of all modern defence equipment. If the best fighters around the world depend on even a single Indian component to perform, the country will have done more to ensure the safety of its arms supplies than any aircraft and tank photo opportunities.

From: The Hindustan Times

India will foot the bill

So for yet another generation, India is going to end up paying for the development of fighters built to someone else's design. The $35 billion deal to "jointly develop" the fifth generation fighter aircraft (FGFA) is a misnomer: India will merely be associated in developing the Indian variant of a Russian fighter, and probably end up paying most of its development costs.

In fact, three prototypes of that fighter already exist and the first flight took place in January 2010. It is called the T-50 or PAKFA. India was not associated in that design work. But it will now cut into the programme by providing the much needed funds and be able to shape the fighter to its requirements. That process will give the Indian Air Force a good fighting machine. But it is unlikely to provide India with what it needs—the ability to design and develop its own top-notch fighters.

The contrast with China is obvious. In 1999, China acquired the designs of the Soviet-era Su-27SK fighter which was then manufactured in China as a joint venture between Knaapo, the Russian manufacturer, and the Shenyang Aircraft Corporation. This was then jointly developed and became the Su-30MKK. The contract was terminated well before all 200 fighters were supplied and thereafter the Chinese have come up with their own reverse engineered aircraft, the J-11 which is also the basis of a new naval variant, the J-15. Out of this is also likely to evolve the J-20 or the Chinese fifth generation fighter.

The Chinese have considerable experience in reverse engineering Russian designs. But India has been unable to do even that though it has paid for licence manufacturing capabilities, first for the MiG-21 series of aircraft, then the Jaguar strike aircraft and finally the Su-30MKI.

Neither has it developed a significant design and development capability despite funding the Light Combat Aircraft project. India has actually ended up paying the development costs for someone else's fighters. In this way, we subsidised the development of the Mirage 2000 aircraft, then of the Su-30 MKI and now we will do it with the FGFA. And then we will pay market prices of the final product for the privilege.

According to HAL, a number of Indian design engineers are to be associated with the FGFA. It remains to be seen as to just how many do end up participating in the programme and what use is made of them thereafter. Whether or not this extends to engine development remains to be seen, though this is unlikely.

The Chinese have been relentless in ensuring that they acquire strategic capabilities in key areas. Military aviation is just one such area. The other is high-speed trains in which China has emerged a world leader in the short space of two decades. The systematic manner in which China imported technology and then insisted on transfer of technology and its dissemination into Chinese research and development institutions is to be admired.

On the other hand, Indian processes are opaque and it is the taxpayer who is eventually landed up with a massive bill. Take the Su-30 MKI, from $32 million per piece in 2000, we are now paying $90 million per copy even though they are allegedly being made from raw materials in India. But it is no secret that India imports all key assemblies and the engine (40 per cent by value of the aircraft).

Indian defence PSUs repeatedly make claims about indigenising products, while they actually cheat the exchequer and the public by buying subassemblies and passing of the final product as their own.

The 2010-2011 CAG report for the air force and navy gives one instance when a PSU claimed it would make 22 of a kind of surveillance radar indigenously. As soon as it got the approval for the 870 crore project, it placed an order for the import of 13 of the 22 in completely knocked down (CKD) form. To top this, the so-called indigenous product cost 78 lakh more than the original imported radar.

Dr Manoj Joshi
From : Mail Today

Lockheed Martin

Towards a strong Navy

For long, modern Indian military history and thinking has been land-focused and therefore army-centric. Much of this has to do with invasions on the country's western front beginning with the Greeks and followed by various Muslim invaders. Yet, the irony is that while all land-based aggressors either plundered and departed or stayed on to rule and subsequently get absorbed, it were the invaders who arrived by sea who ended up colonising the country. They comprised the British, the Portuguese and, in small measure, the Dutch.

It is only in recent years that the Indian Navy has begun getting due importance. From its first post-Independence military engagement in 1961 when it provided fire support to the Army's landing troops during the liberation of Goa, the Navy has added to its history a long list of operations and engagements that include the blockade of East Pakistan (now Bangladesh) and bombing of Karachi Harbour during the 1971 war; engagements in the Maldives and Sri Lanka in the late 1980s: deployments in the Northern Arabian Sea during the Kargil war; relief missions to as far as Indonesia, Sri Lanka and the Maldives following the horrific Tsunami; evacuation missions from war-torn Lebanon; anti-piracy operations off the coast of Somalia and several UN peace support operations.

The Navy has emerged crucial to India's strategic interests that extend from the Strait of Malacca to the Strait of Hormuz and other 'choke points' in the Gulf considering that it is located astride the world's most critical sea lane of communication that is used for transporting a considerable quantum of trade, chiefly oil. The Navy has emerged as a valuable instrument of diplomacy by engaging in numerous bilateral and multilateral exercises and port visits. For India to be able to develop a credible second-strike capability, the soon-to-be inducted nuclear-powered submarines are critical. India could take a leaf from the navy of the country with the world's largest Muslim population, Indonesia, whose motto is *Jaleseva Jayamaha*, a phrase derived from Sanskrit, meaning 'On the sea we are glorious' and whose crest is the Brahm-astra, which symbolises the ultimate weapon of mass destruction.

From : The Tribune

Cool it

Mesmerised by China's vast military build-up, a new constellation of strategic partnerships among its neighbours, and America's revitalised commitment to Asian security, many observers suggest that 2010 saw the first sparks of a new cold war in Asia. But is a second cold war really inevitable?

Although appeasing China's drive for hegemony in Asia is unthinkable, every realistic effort must be made to avoid militarisation of the region's diplomacy. After all, there was nothing very cold about the cold war in Asia. First in the Chinese civil war, and then in Korea, Indonesia, Malaysia and Indochina - particularly Vietnam - the cold war raged not as an ideological battle between rival superpowers, but in dogged, often fratricidal combat that cost millions of lives and retarded economic development and political democratisation.

It is this grim history that makes China's current disregard for Deng Xiaoping's maxim that China "disguise its ambition and hide its claws" so worrying for other Asian leaders. From its refusal to condemn North Korea's sinking of the South Korean warship *Cheonan* to its claims of sovereignty over various Japanese, Vietnamese, Malay and Filipino archipelagos, and newly conjured claims on India's province of Arunachal Pradesh, China has revealeda neo-imperial swagger. So it should surprise no one that"containment" is coming to dominate Asian diplomatic discourse.

But it is wrong - at least for now - to think that a formal structure of alliances to contain China is needed in the way that one was required to contain the Soviet Union. Containment, it should be recalled, was organised against a Soviet totalitarian regime that was not only ideologically aggressive and in the process of consolidating its colonisation of Eastern Europe but also deliberately sealed off from the wider world economy.

Today's China is vastly different. Overt military imperialism of the Soviet sort has, at least historically, rarely been the Chinese way.More importantly, China abandoned autarky three decades ago. Today, its economic links in Asia are deep and - it is to be hoped - permanent.

Throughout China's three-decade rise from poverty to economic juggernaut, trade within East Asia has grown even faster than the region's trade with the rest of the world, suggesting deeper integration. Indeed, China's rise has profoundly altered the course of Asia's trade flows.

Given that as many as half of China's 1.3 billion people remain mired in abject poverty, it is in China's interest to ensure that these economic relationships continue to flourish. In the past, China has recognised the vital need for good neighbourly relations. During the Asian financial crisis of 1997-1998, Chinese officials did not engage in competitive devaluation of the renminbi. Unfortunately, such clear-sighted and responsible policymaking is a far cry from what we are seeing today.

China's dizzying increase in its military capacity is a source of concern in Asia. But, even according to the highest estimates, China's military budget is only now about equal to that of Japan and, of course, much less than the combined military budgets of Japan, India and Russia, all of which border China.

So the challenge that China poses today remains predominantly political and economic, not military. The test of China's intentions is whether its growing economic and, yes, military capacities will be used to seek to establish Asian hegemony by working to exclude America from the region and preventing regional partnerships from flourishing. The alternative is a China that becomes part of a co-operative effort to bind Asia in a rules-based system similar to that in Europe.

In this sense, Asia's rise is also a test of US competitiveness and commitment in Asia. America's historical opposition to hegemony in Asia remains valid. It will have to be pursued, however, primarily by political and economic means.

Before 2010, most Asian countries would have preferred not to choose between China and the US. But China's assertiveness has provided enormous incentives to embrace an Asian multilateral system backed by America, rather than accept the exclusionary system that China seeks to lead. In 2011, we may begin to see whether those incentives lead China's rulers to reappraise their diplomatic conduct, which has left them with only the corrupt, basket case economies of Burma and North Korea as reliable friends in Asia.

Yuriko Koike, Japan's former minister of defence,
From : South China Morning Post

Northrop Grumman

VISION

Tejas: Light at the end of the Tunnel ?

Admiral Arun Prakash, former Chief of Naval Staff, writes on formal induction of the Light Combat Aircraft (LCA) or Tejas into the IAF on 10 January 2011.

This is not just an historic landmark for our aerospace industry, but a significant step forward in India's quest for 'great power' status. No more than a handful of countries can claim the ability and competence to successfully bring a project of such complexity to fruition. It would therefore be churlish not to acknowledge the achievement of our aircraft designers, scientists, production engineers, and the flight-test team for having – albeit belatedly – delivered a state-of-the art combat aircraft to the IAF.

With the accord of Initial Operational Clearance (IOC), the Tejas is now at the same stage where India's first nuclear submarine, the *Arihant*, was, on its launch in 2010. Both these strategic and prestigious platforms are on the threshold of entering service, but with a fairly arduous road to traverse before attaining fully operational status. The achievements (and failures) of the DRDO, invariably, evoke strong emotions amongst the Indian public as well as the cognoscenti. However, at a juncture such as this, it is essential to draw right lessons for the future, without yielding either to dreamy-eyed euphoria or to negative skepticism.

The dimension in which the LCA project has attracted most criticism is the successive time and cost overruns that it experienced. While it is not easy for an outsider to pinpoint the specifics, it is still possible, with the benefit of hindsight, to draw some general conclusions. The most prominent of these is the obvious over-estimation of its own competence by the DRDO. This led to the ambitious claim that they had the capability to develop, in-house, not just the airframe and engine, but also the radar as well as a complex fly-by-wire (FBW) flight control system required for an 'agile' (or aerodynamically unstable) fighter. This 'showing-off' was compounded by the trotting out of hopelessly optimistic cost and time estimates on the incorrect premise that since India had, earlier, designed and built the HF-24 *Marut* we possessed the design skills and manufacturing expertise.

The *Marut*, putatively India's first indigenous fighter, aircraft had, in actual fact, been designed by a contracted German team led by Prof Kurt Tank, designer of the famed WW II Focke-Wulf FW-190 fighter. Inducted into the IAF in 1967, the *Marut* was only a qualified success, its advanced airframe however being mismatched with a pair of under-powered Orpheus engines. The assumption that the advanced LCA would benefit from the expertise acquired from the 30-year earlier *Marut* project was, therefore, largely fallacious.

The second contributory cause was the decision of the DRDO, typically, to pursue this strategic project without ensuring adequate involvement of the end-users: the armed forces. The IAF, understandably, more concerned with extant problems of meeting its operational roles and missions took a rather detached view of the LCA and remained focused on looking abroad for its needs. This lack of active interest and involvement by the intended end-user of the LCA, which persisted for many years, arguably deprived the project of impetus, moral support and of funding.

The last and most crippling impediment for the project was posed by denial of

Alonia Aeronautica

crucial technologies by the west. Starting in 1974, after Pokhran I, America started shutting the technology tap for India. However, post-liberalisation, finding a window of opportunity, advice and consultancy in certain key areas of the LCA design, notably the FBW system, was obtained from American as well as British aerospace firms. Unfortunately, the sanctions imposed after Pokhran II brought this crucial cooperation to an abrupt halt. This is where our scientists showed their true mettle and went on to develop and qualify the incredibly complex flight control algorithms, almost entirely on their own.

The sophisticated software for flight control, weapon-aiming, air-data and other computers carried by the *Tejas*, and the carbon-fibre composite technology for its light-weight fuselage are the pride and joy of our scientists. Apart from this, the electro-hydraulic actuators for the controls, the pumps, motors, instruments and many of the major systems have all been developed by scientists working in dozens of DRDO laboratories, and produced by industrial units across the country. The seeds of an aerospace ancillary industry have been planted and will hopefully be nurtured by a long production run of the *Tejas*.

It has not been so well known that the Indian Navy (IN), in consonance with its commitment to indigenous development, has not only remained a steadfast supporter, but has also been the only agency, apart from DRDO, to make a financial commitment to this inchoate project. A brief glance at the IN involvement brings out the contrasting approach of the two Services to this project. In the early 1990s, as the LCA programme was tending to languish, NHQ made enquiries about the possibility of a ship-borne version of the aircraft, and received an enthusiastic response from the Project Director Dr. Kota Harinarayan. Preliminary examination having shown that it was, *prima facie*, a practicable proposition, it was decided to initiate a project definition study which would chart a developmental roadmap and pinpoint possible impediments.

Accordingly, the LCA (Navy) project was accorded formal recognition and a sum of Rs. 4 crores sanctioned by NHQ for undertaking the study. Closer examination of this proposal revealed some major problem areas, which included lack of engine thrust, requirement of a new (stronger) undercarriage and arrester hook and need for fuselage re-design, before the LCA could attempt carrier operations. Undaunted, the Navy re-affirmed its faith in the programme by writing out Qualitative Requirements and initiating a jointly-funded engineering development programme in 2003 with the IN contributing over Rs. 400 crores as well as engineers and test pilots to the project. Construction of a unique dummy carrier deck was initiated at Goa airfield for testing the performance of LCA Navy during ski-jump launches and arrester wire landings.

The prototype of LCA (Navy) was rolled out in July 2010 and although problems of excess weight and inadequate engine thrust persist, there is optimism about the project. This project is seen by the IN as a pioneering initiative, whose success will place India in a select list of just three countries which can currently produce carrier-borne aircraft. This venture speaks as much of the Navy's vision as of the ingenuity of our aircraft designers, and its completion will provide an invaluable boost to our defence-technology base as well as industry.

However, for all its good work and achievements, there remain two critical areas in which the DRDO has sadly disappointed the nation and contributed to delays in the LCA project. One is, of course, its failure to deliver the fighter's primary sensor, a multi-mode radar which, eventually had to be imported. The other is the long-awaited *Kaveri* aero-engine, which has remained, for 40 years, in limbo. Far from attaining its promised performance parameters it was yet kept alive to justify the existence of its parent Gas Turbine Research Establishment (GTRE). Having missed all deadlines and targets, GTRE has at last seen the light and sought foreign collaboration to assist in its development. The US-origin General Electric F-414 engine recently contracted for the *Tejas* barely meets its thrust requirements and the heavier LCA Navy will need an even more powerful engine for carrier operations. One can only hope that the improved *Kaveri* engine that eventually emerges will produce enough thrust to power the LCA Navy and Tejas Mark II.

Twenty-seven years and Rs. 17,000 crores down the line, the LCA experience has created a number of important lessons for India. Firstly, DRDO should not be permitted to undertake any major project whose Staff Targets have not originated from the Defence Acquisition Council or Chiefs of Staff Committee. Once the project is approved the sponsoring Service must associate intimately with DRDO to refine the Staff Requirements, and contribute uniformed personnel as well as funding during development. It is also, perhaps, time for the IAF to create an establishment on the lines of the Navy's Directorate of Naval Design to conceptualise its future aircraft requirements.

With globalisation, the quest for attaining autarchy in every aspect of technology has become a redundant activity. A conscious and early decision must be taken in every R&D project regarding the technologies we need to develop in-country and those that we can acquire from abroad. Developmental projects undertaken by the DRDO must have fairly rigid time-frames, after which they should become candidates for review and abortion. The DRDO practice of in-house "peer reviews" of projects by scientists must be replaced by hard-nosed audits and progress-checks by independent experts, as well as end-users.

Six decades after independence, some 80% of our military hardware remains of foreign origin and India has the dubious distinction of being amongst the top arms importers in the world. The comprehensive capability to design and undertake serial production of major weapon systems and ordnance is an imperative that has, so far, eluded us. Not only is this a serious flaw in our national security, but our lofty claims to big-power status will ring hollow as long as we remain dependent on imports for major weapon systems.

Still, for all the scorn and criticism that we often (justifiably) heap upon DRDO and our PSUs, the fact remains that, properly restructured and synergised with India's innovative private sector, both these national institutions have the capability to rescue India from the unending arms-dependency trap. First the *Arihant* and now the *Tejas* have provided tangible proof of this.

Snecma

Cleaning the Augean Stables

It is with trepidation that one opens the morning newspapers these days or tunes into the electronic media, for fear of being exposed to further news of damage to the revered institution of our armed forces. An institution that has upheld the honour and integrity of the country, not only through wars and combating insurgencies in different parts of the country, but also in providing relief during natural calamities and international peace-keeping operations with the United Nations.

Even as we read the sombre interview of the chief of army staff, expressing anguish at the damage to the institution of the army resulting from the Adarsh Housing Society episode, another newspaper broke the news of a scandal involving the air force and naval housing board with an erstwhile naval chief being named. The nation must wonder how many more skeletons lie buried. If the leadership can let down the men and women they command then letting the country down is but a small incremental step.

The bigger danger is to those of our serving men and women on whose shoulders rests the responsibility of keeping our future secure. How are they to differentiate between commanders to be respected and those to be shunned? And when the moment of reckoning comes, could this fleeting doubt make a difference between obeying a lawful command blindly or pausing to reflect? These are harsh questions, but in the context of the unimpeachable integrity expected of our armed forces, they need to be posed.

While it is not the writer's case to pass judgment on those that are being named in various exposés, it is to the wider damage to the very fabric of our armed forces and their morale that our attention must be drawn. After all, the vital ingredient of a potent fighting force is morale, which is not born out of any magic potion that commanders can administer, but out of the unshakeable trust and resulting bond between the leaders and the led. Morale is high when commanders enjoy the blind confidence of the men they command. Good commanders can feel the morale of their troops in their bones — certainly morale is not displayed on uniform sleeves.

If today there is a perception among many commentators and including this writer about the profound impact of all this adverse publicity on the morale of the armed forces, it is amply justified. The reality is that whilst most of us have the luxury of watching this drama unfold from our drawing rooms and to indulge in sterile debate, to those of our forces that are manning our borders, skies and oceans it is a question of whether the larger commitment to the cause for which they are risking their life and limb daily is real or hollow.

There are three distinct facets of life in our armed forces. The first relates to our field formations, on which rests the war-fighting capability of the nation. It is here that the officers work and train to become true leaders through baptism by fire and it is here that, in peace and war, our young soldiers and officers

Agusta Westland

are giving their youth so that the nation may get on with its life. In the bargain, unsung martyrs are born daily. For them there is no breaking news and no obituary. They and their families are left to mourn in silent dignity and to face an uncertain future. Significantly, this is also where the armed forces remain cocooned from the civil side of national governance and hence uncorrupted by its rapid degeneration. Having had the privilege to command such a body of men and women, this writer can predict confidently that they will remain so, no matter where our decaying governance or politics takes us. To that extent the nation can heave a collective sigh of relief.

There is, though, another variant of this facet when the armed forces are called upon to aid civil authority, as has happened for over six decades in the various states of the Northeast and for over a decade in Jammu and Kashmir. Here, not only are these field formations exposed to the politics of the states and the civil administration, but they are sometimes even made targets of the very governments whose chestnuts they have been called upon to pull out of the fire. In such situations, the armed forces find themselves between a rock and a hard place. Of late, state governments in both Manipur and Jammu and Kashmir have targeted the Armed Forces Special Powers Act, painting it to be something that the armed forces use to abuse human rights. The lawmakers who have enacted the law, and the government that implements the law, have failed to dispel this motivated notion, remaining ambivalent. It has been left to the service chiefs to defend what legitimately should have been the task of the government. It is the right of civil governments in a democracy to exercise full authority over the armed forces, but this carries with it an obligation to keep them insulated from politics. Failing to do so and sitting on the fence on critical issues bodes ill for both our democracy and the institution of the armed forces.

This brings us to the third facet, which is the management of the armed forces at the command and service headquarters level and their interface with the various ministries and departments of the government, the bureaucracy and the political leadership. It is here that the foundation of years of leadership and training in the field is either built upon or shattered. When exposed to the unfettered power of a bureaucracy without accountability, the lack of understanding and the indifference of the political leadership to all things military and to the sheer power of patronage within the system, many a potential senior service leader falls prey. The short-term benefits to their careers, postings, promotions and, in some cases, even financial or post-retirement opportunities are far too tempting to let go of. Thus an unholy nexus is created at variance with the fabric of the institution of the armed forces. The *Adarsh* episode is a clear example of this.

This is by no means a new phenomenon. For decades now, promotions to higher ranks and to commanders and chiefs have been subject to both political and bureaucratic patronage, as is well known in the corridors of the service headquarters. Rules have been manipulated and various tricks used to benefit the privileged and pull down the deserving. In some cases, chiefs who were themselves beneficiaries of this munificence are co-opted to perpetuate this injustice. That the Service takes it in its stride and continues to perform merely substantiates what has earlier been said about our field formations. But this dichotomy cannot last forever, especially in the present information age. The cracks are now beginning to show and, as the recent series of scandals indicate, they are by no means hairline, they are crevasses!

In the past, every instance of wrongdoing at the highest levels of the armed forces has drawn instant notice, debate and retribution in keeping with the special acts that apply to the respective armed forces. While this is necessary and keeps the institution of the armed forces on its toes and holds it accountable, the other systemic institutional weaknesses and lapses are simply glossed over. So, after *Tehelka,* the only people punished were those in uniform, with all others remaining untouched. Today, all eyes are on the army and its chief. Where, one wonders, is the ministry of defence, which is directly responsible for the director-general of defence estates, whose officers are also within the *Adarsh* net and perhaps the brains behind it? It is these double standards that are not lost on those serving in uniform.

The truth, however, is that the way our higher defence organisation is structured, in every important area, from procurement to promotions and postings of senior officers, the authority rests with the Ministry of Defence and not with the service headquarters. There is thus a strong motivation to maintain *status quo,* and that is why the integration of service headquarters with the ministry of defence, a long overdue reform and one recommended by the Kargil review committee continues to be resisted. After all, exercising unfettered authority over the armed forces with no corresponding accountability is too attractive an incentive to surrender.

Now that there is suspicion that many of our very senior armed forces officers have conducted themselves in a manner not befitting the positions that they hold, the nation must ask how such people were able to reach the pinnacle of their careers, where the promotional pyramid is not only steep but competition extremely tough? Indeed, how many more are there whose misdeeds lie unexposed? What role did institutions other than the armed forces — namely, the Ministry of Defence, the Intelligence Bureau and the cabinet committee on appointments — play in failing to be diligent, and were these merely errors of omission or of commission as well? What are the organisational weaknesses that have allowed such fatal lapses in the security of the nation to take place and, importantly, what must be the institutional lessons learnt?

If allegations of severe wrongdoing for personal gain can be laid at the doors of chiefs and commanders who were serving, then no time can be lost in cleaning the Augean stables. The nation is at the end of its tether and people are owed an assurance. At the level of individual service, this can be done best by each service conducting a self-cleansing exercise, including those high-ranking veterans whose integrity has been the subject of whispering campaigns. At the national level, this writer can only repeat what was recommended earlier: setting up a blue ribbon commission not just to find answers to the vexed questions asked above, but to that of where the nation wants to peg the institution of its armed forces.

Air Marshal (Retd) Brijesh Jayal

CAE

India and Russia strategic agreement on FGFA

The Governments of India and Russia have recently signed a number of strategic agreements including co-development of the fifth generation fighter aircraft and the building of two Russian nuclear reactors. The accords were signed following talks in New Delhi between Russian President Dmitry Medvedev and Indian Prime Minister Manmohan Singh on 22 December 2010.

The accord on jointly developing a fifth-generation fighter with stealth capabilities estimated at $30 billion, with India planning to induct 250-300 aircraft in the IAF (see *Vayu* VI/2010) was then formalised. In a joint statement, the Russian President also voiced support for India "as a deserving and strong candidate" for a permanent seat in an expanded UN Security Council.

FGFA (PMF) preliminary design contract signed

The memorandum for preliminary design of the Indo-Russian Fifth Generation Fighter Aircraft (FGFA) was signed between Hindustan Aeronautics Limited (HAL), Rosoboronexport and Sukhoi on 21 December 2010. The FGFA will have advanced features such as "stealth, supercruise, ultra-manoeuvrability, highly integrated avionics suite, enhanced situational awareness, internal carriage of weapons and network centric warfare capabilities."

The aircraft to be jointly developed, has now been termed as the 'Perspective Multi-role Fighter' (PMF) which draws upon the basic structural and system design of the Russian PAKFA or T-50 to meet the IAF's specific requirements. The broad scope of bilateral cooperation covers the design and development of the PMF, its productionisation and joint marketing to third countries. Programme options include the design and development of a twin-seater variant and integration of an advanced engine with higher thrust at a later stage.

This contract is the first in a series of such commitments which will cover different stages of this long-term and complex programme.

In the photograph taken at the contract signing on 21 December 2010 at New Delhi are seen seated (left to right) M. Pogosyan, General Director RAC-MiG & Sukhoi, A. Isaykin, General Director, Rosoboronexport from the Russian side, and Ashok Nayak, Chairman HAL with N.C. Agarwal, Director (D&D), HAL from the Indian side.

Tejas LCA 'released for service' (IOC)

Termed as the function for 'Initial Operational Clearance' of the Tejas Light Combat Aircraft, the Minister for Defence AK Antony handed over the 'Certificate of Release to Service' to the Chief of Air Staff, Air Chief Marshal PV Naik at the HAL airport in Bangalore on 10 January 2011. The ceremony

Tejas LCA in flying display following the Initial Operational Clearance in Bangalore on 10 January 2011.

was preceded by addresses and briefings by Director ADA and the Chairman HAL. Dr VK Saraswat, SA to Defence Minister and RK Singh, Secretary Defence Production spoke before the address by Air Chief Marshal PV Naik who thereafter received the 'Certificate' from the Minister.

As Mr Antony said, "After crossing a number of challenges and accomplishing a significant series of milestones of envelope expansion, sensor integration and weapon delivery in over 1500 sorties, the country is poised for a major turning point with the declaration of Initial Operational Clearance of the Tejas. The Centre for Military Airworthiness and Certification (CEMILAC) have painstakingly evolved the roadmap for *Release to Service Certification* and finally ensured all goals are accomplished. This would facilitate delivery of the first lot of twenty production standard aircraft to the Indian Air Force with assured safety and specified performance before the end og the year. I am also happy to announce that the Government has cleared the next lot of 20 Series Production aircraft and I am confident that there will be a progressive improvement in the standard of build. Further, there is scope for supply of Mk.2 variants for the Navy and Air Force. The estimation is that the nation needs about 200 Tejas aircraft."

Scientific Adviser to Raksha Mantri and DG ADA Dr VK Saraswat presenting a model of Tejas LCA to Defence Minister AK Antony during the IOC function at Bangalore. They are flanked by Air Chief Marshal PV Naik and Dr PS Subramanyam.

Mr Antony singled out Dr Kota Harinarayana for his pioneering role in the LCA Programme. The first of two IOC-configured LCAs would be handed over to the IAF by March 2011 with another two towards the year end. The series production of 20 Tejas aircraft has commenced and will be progressively delivered to the IAF which will re-form No.45 Squadron on the type, to be based at Salur near Coimbatore.

Spectacular order by IndiGo for 180 A320s

On 11 January 2011, the country's largest low-cost carrier, IndiGo signed a Memorandum of Understanding for 180 eco-efficient Airbus A320 aircraft of which 150 will be A320neos, for a total cost of $15.6 billion. This is the largest single firm order number for airliners in commercial aviation history, which also makes IndiGo a launch customer for the A320neo. Engine selection is to be announced by the airline at a later date. The

aircraft themselves are to be delivered between 2016 and 2025 after Indigo takes delivery of all 100 A320s from its previous order, over one-third of which are currently in service.

The Gurgaon-based carrier concluded the order for around Rs. 70,000 crore in anticipation of going international later in 2011 after it completes five years of domestic operations. The low cost carrier has now displaced Air India to become the country's third largest airline with a market share of 17.3%. IndiGo sources said the airline was planning an initial public offer (IPO) of shares to fund the purchase that would make it the launch customer for the A320neo, the latest from Airbus which incorporates new more efficient engines and large wing tip devices called 'Sharklets' delivering significant fuel savings of up to 15 percent, representing some 3,600 tonnes of CO2 annually per aircraft.

"This order for industry leading fuel efficient aircraft will allow IndiGo to continue to offer low fares," said Rakesh Gangwal and Rahul Bhatia, co-founders of IndiGo. "Ordering more A320s was the natural choice to meet India's growing flying needs. The opportunity to reduce costs and to further improve our environmental performance through the A320neo was key to our decision."

IndiGo currently operates 221 scheduled flights a day, connecting 24 destinations in India and plan to launch international services on 15 sectors.

Final assembly of IAF C-130Js

The next three Lockheed-Martin C-130Js for India have reached the final production positions at the Martin Marietta facility and will join the previous three, which are being handed over to the Indian Air Force, the first being formally delivered on 16 December 2010 at a ceremony in Marietta. Two will be flown to India in early 2011, while two more are to arrive in early summer with the last two delivered in late summer of 2011.

First C-130J Super Hercules handed over to IAF

On 17 December 2010 Lockheed Martin delivered the first of six C-130Js to the Indian Air Force. The new fleet was ordered under a $1.2 billion U.S. Foreign Military Sale (India's first) in late 2008 and includes six aircraft, training of aircrew and maintenance technicians, spares, ground support and test equipment, servicing carts, forklifts, loading vehicles, cargo pallets and a team of technical specialists who will be based in India during a three-year initial support period. Also included in the package is 'India-unique' operational equipment designed to increase Special Operations capabilities. The first two C-130Js will be flown to India early in 2011 to be followed by the remaining four aircraft deliveries in 2011.

Formal induction of the C-130Js will take place at Air Force Station Hindon in early February 2011 when the newly-raised No. 77 Squadron IAF will be formed with the Super Hercules.

"The Indian Air Force's C-130J Super Hercules is a highly integrated and sophisticated configuration essentially designed to support India's special operations requirement." Equipped with an Infrared Detection Set (IDS), the aircraft can perform precision low-level flying, airdrops and landing in blackout conditions. Self-protection systems and other features are included to ensure aircraft survivability in hostile air defence environment. The aircraft is also equipped with air-to-air receiver refuelling capability for extended range operations.

"The C-130J is ideally suited to India's mission environment, which often involves operating out of austere, high-elevation airstrips in hot conditions. The C-130J is powered by four Rolls Royce AE2100 engines and Dowty six bladed props which provide the aircraft with a great deal of power." The C-130J has operated in the mountainous areas of Afghanistan in conditions similar to northern India for the past several years and performed "exceptionally well".

It is understood that Lockheed Martin are in discussion with the Indian Government for a follow-on order of six additional C-130J Super Hercules transport aircraft through the Foreign Military Sales route. It is also, separately, in talks with the Ministry of Defence over the supply of its Javelin antitank missile systems.

Tejas completes drop tank jettison trials

Dr. PS Subramanyam, Programme Director (CA) and Director, ADA stated that "the 1200-litre drop tank jettison trial was conducted on 17 December 2010 at a critical point in the jettison envelope on Tejas LSP-3 aircraft piloted by Gp Capt Suneet Krishna. The trial was conducted over the recently commissioned NFTC Air to ground range at Chitradurga, with the trial aircraft escorted by another Tejas (PV-2) capturing the external video picture of the drop tank trajectory after release". Dr Prahlada, CC R&D (Ae-SI) at DRDO opined that "with such test experiments made by the team, the aeronautical test range facility at Challakere has paved the smooth way for subsequent trials of different natures. He added that "if this facility were not to be commissioned at Challakere, all such flight tests would have to be carried on either at Hyderabad or Pokhran. In view of the close proximity of Challakere to Bangalore it was more comfortable in conducting the test flights by the dedicated team the process of which could be monitored from Bangalore".

The flight test was planned by the National Flight Test Centre (NFTC), ADA at certain representative critical release condition. Considering the safety critical nature of this test, a safety review was conducted at NFTC to ensure all foreseeable safety issues before embarking on this important test. To capture the flight data, a dedicated and specialised Airborne Separation Video System (ASVS) is installed on the Test aircraft. The system comprised very high speed digital cameras installed in a specially designed camera pod and linked to a Multi System Controller (MSC) installed onboard the aircraft. The MSC gets a pulse from trigger to jettison the tank after which the cameras are switched on in a pre-determined sequence to capture this critical event.

Cluster bomb units from US

The US department of defence has announced the sale of 512 CBU105 sensor-fuzed weapons (SFWs) produced by Textron Systems Corp. to India for an estimated $257 million (Rs.1,162 crore). According to a statement issued by the company, in addition to the 512 SFWs, the contract provides for 44 training units. India will procure these weapons under the US government's foreign military sales programme.

'Type Approval' for LCA gearbox

CVRDE at Avadi has designed and developed an Aircraft Mounted Accessory Gearbox (AMAGB) for the Tejas Light Combat Aircraft as pre-curser to its induction into the Indian Air Force, with 'Type Approval' from CEMILAC (Centre for Military Airworthiness and Certification).

Dr. K. Tamilmani, Chief Executive CEMILAC handing over the Approval Certificate to P. Sivakumar, Director CVRDE.

Cobham equipment for IAF Hawks

Cobham is to supply Weapons Carriage and Release equipment for Indian Air Force Hawk Advanced Jet Trainers. Cobham's Mission Equipment strategic business unit will deliver "significant quantities" of Light Duty Ejector Release Units and Carrier Bomb Light Stores (CBLS) training aids to BAE Systems between 2012 and 2014. Cobham's contract award follows the IAF purchase of an additional 57 BAE Hawks in July 2010, to be built by Hindustan Aeronautics Ltd in India. Forty aircraft have been assigned to the Indian Air Force and the remaining 17 will be operated by the Indian Navy.

Tata Group stake in HBL Elta Avionics

Tata Advanced Systems (TAS) has acquired a 74% stake in Hyderabad-based HBL Elta Avionics for "an undisclosed amount". The remaining 26% continues to be held by its foreign partner Elta Systems, a unit of Israel Aerospace Industries (IAI). TAS bought controlling interest in HBL Elta from HBL Power Systems , a company listed on the BSE.

This will be Tata's second JV with IAI with whom it has a 74:26 partnership to manufacture unmanned aerial vehicles, electronic warfare systems, missiles, radars and homeland security systems. IAI chief executive Itzhak Nissan and Tata Sons Chairman Rata Tata reportedly have various plans to build a multibillion dollar enterprise in the defence sector.

The Tata Group expects defence to be an estimated $5 billion business in the near future and have a few partnerships with foreign companies. Apart from the joint venture to manufacture cabins for Sikorsky S-92 helicopters, TAS also has a joint venture with AGT International to provide integrated solutions for homeland security market.

"In anticipation of the Apache selection"

The US Defence Security Cooperation Agency notified Congress on 22 December 2010 of a possible Foreign Military Sale to the Government of India of various engines, equipment, weapons, training, parts and logistical support for a possible Direct Commercial Sale of 22 AH-64D Block III Apache helicopters, the complete package worth approximately $1.4 billion.

The Government of India had initiated evaluation of several types to provide the next generation attack helicopter for the Indian Air Force, but has yet to select the Boeing-United States Army proposal. "This notification is being made in advance so that, in the event that the Boeing-U.S. Army proposal is selected, the United States might move as quickly as possible to implement the sale". If the Boeing-U.S. Army proposal is selected, the Government of India will request a possible sale of 22 AH-64D Block III Apache Helicopters, plus 50 T700-GE-701D engines, 12 AN/APG-78 Fire Control Radars, 12 AN/APR-48A Radar Frequency Interferometers, 812 AGM-114L-3 Hellfire Longbow missiles, 542 AGM-114R-3 Hellfire II missiles, 245 Stinger Block I-92H missiles, and 23 Modernised Target Acquisition Designation Sight/Pilot Night Vision Sensors, rockets, training and dummy missiles, 30mm ammunition, transponders, simulators, global positioning system/inertial navigation systems, communication equipment, spare and repair parts; tools and test equipment, support equipment, repair and return support, personnel training and training equipment; publications and technical documentation, U.S. Government and contractor engineering and logistics support services; and other related elements of logistics support to be provided in conjunction with the proposed direct commercial sale.

Eurocopter

President's Standards awarded

President of India Pratibha Devi Singh Patil awarded the Presidential Standard to No.31 Squadron and Colours to No.9 Base Repair Depot (BRD), during a ceremonial parade held at Air Force Station, Lohegaon on 8 January 2011. Commanding Officer of No.31 Squadron, flying Sukhoi Su-30MKIs, Wg Cdr Ashutosh Srivastava received the Standard while Air Officer Commanding of 9 BRD, Air Commodore BR Chandran received the Colours from the President.

IAF Operational Squadrons become eligible for award of Presidential Standards after completion of 18 years, while Base Repair Depots and Training Institutions become eligible for award of Presidential Colours after 25 years. The selection is based on their past record and achievements during peace as well as hostilities and acknowledges "the rich heritage and impeccable record of meritorious service rendered by the units".

No.31 Squadron was formed at Pathankot on 1 September 1963 with Mystere IVAs and took part in both the wars with Pakistan in 1965 and 1971 in the ground attack role in support of the Indian Army on the western front. The squadron later re-equipped with the HF-24 Marut, before re-equipping with the MiG-23BN in 1983 which it flew till its number plating in September 2003. The Squadron was resurrected on 1 January 2009 at Air Force Station Pune.

No.9 BRD undertakes major repair and servicing of a variety of avionics, ground-to-air communication equipment, radar and navigational aids and airfield support equipment. It is now on the threshold of inducting new repair lines which would significantly enhance its support to Air Operations. The Depot, initially known as the Base Signals Repair Unit (BSRU), was formed on 1 May 1957 with the amalgamation of two sections, Wireless Repair Section and Radio Repair Section and re-designated as No.9 BRD on 1 April 1966.

BSF aircraft procurement "uncertain"

Following detection of major discrepancies, the Government is likely to re-tender for procurement of medium transport aircraft required by the Border Security Force (BSF). As per the Home Ministry's plan for the BSF, the induction of three medium transport aircraft and eight medium lift helicopters had been approved for expansion of the BSF Air Wing.

Mi-17 V5 helicopters for the IAF

Deliveries of the 80 Mi-17 V5 medium lift helicopters ordered for the Indian Air Force in December 2008, will commence from March 2011 and be completed by 2014 which also involves an offset obligation by the Russian company amounting to $405 million.

According to Defence Minister AK Antony, the new Mi-17s are slated to replace the obsolescent Mi-8s, in service with the IAF since the 1970s. "The helicopters will be utilised for special heliborne operations, air maintenance, troop and equipment transportation, search and rescue, casualty evacuation and in armed helicopter roles."

"Defence sales cornerstone of India-US ties"

The US secretary of commerce Gary Locke has conveyed the US view that "high technology defence sales to India are a cornerstone of the strategic partnership between the two countries." Such an expression of intent has not been spelt out so clearly before, being conveyed to India's ambassador in the US Meera Shankar at a meeting in Washington on 13 January 2011.

Gary Locke will be leading a large trade mission to India and some 70 US companies have applied to be on his mission, the companies including defence majors an others dealing in security, civil aviation, information and communications technology.

Spicejet order 15 Bombardier Q400 NextGens

SpiceJet has placed a firm order for 15 Q400 NextGen turboprop airliners from Bombardier Aerospace and has taken options on an additional 15 airliners. "India is witnessing substantial growth, and predominant expansion is expected from

cities and industrial towns which remain underserved," said Kalanithi Maran, Chairman of the Board of Directors, SpiceJet. " After an evaluation of all the aircraft in the 60 to 80 seat category, we have selected the Q400 NextGen airliner, which combines excellent reliability, economics and passenger comfort."

Gary R. Scott, President, Bombardier Commercial Aircraft added, " We expect India to take delivery of 600 commercial aircraft in the 20-to 149-seat category over the next 20 years, and we believe our optimised Q400 NextGen turboprop, CRJ Series regional jets and all-new CSeries aircraft are ideally suited to capture a sizeable portion of those deliveries."

First RNP flight

Airbus' Quovadis RNP subsidiary and IndiGo have successfully demonstrated at the Cochin International Airport, the first 'Required Navigation Performance' (RNP) flight of any commercial airliner in India.

Specially developed by Quovadis, the RNP procedure for this airport was validated using Airbus flight simulators. Following this successful flight by an IndiGo A320, Jet Airways will soon demonstrate this procedure using a Boeing 737-800. All operators with 'RNP capable' aircraft will benefit from RNP approaches at Cochin airport, once the new procedures have been officially published by the authorities.

The new procedure for India, which has been jointly financed by Airbus and the French Civil Aviation Authority (DGAC), brings a number of benefits to both local authorities and airlines at Cochin International Airport which include a fully managed approach on contained trajectories, a much shorter flight path saving 40nm for operators on each approach, equating to approximately 1,000 lbs fuel saved per landing, whilst reducing noise emissions and easier air traffic management especially in areas with reduced or no radar coverage.

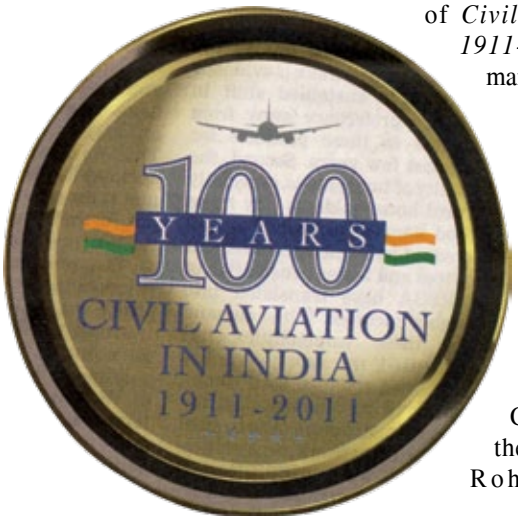
'Jal Hans' launched

The seaplane division of Pawan Hans Helicopters was inaugurated by civil aviation Minister Praful Patel at Mumbai on 27 December 2011, with one Cessna Caravan 208A, single-engined aircraft (VT-MHB) having a seating capacity of eight passengers. The Minister said that seaplane services would be initiated in the Andaman & Nicobar Islands as per an agreement between that administration and Pawan Hans to connect Port Blair with Havelock and subsequently other islands in North Andaman.

The Minister said that it was planned to expand such services to other offshore islands and coastal destinations and that the Government was considering 100% foreign direct investment (FDI) in this sector. Seaplanes would be based in areas including the Lakswadeep, Goa and Orissa.

Civil Aviation Ministry forms 'Centenary Celebration Committee'

On 17 January 2011, Praful Patel, the then Minister of Civil Aviation, chaired a meeting at New Delhi to review plans for marking the centenary celebrations of *Civil Aviation in India : 1911-2011* "in a befitting manner".



The Minister was flanked by former Civil Aviation Minister Ananth Kumar and present Minister of State Commerce and Industry, Jyotiraditya Scindia and other politicians while Dr Nasim Zaidi, Secretary Civil Aviation set the theme for deliberations. Rohit Nandan, Joint Secretary in the Ministry gave an overview of the last 100 years, however beginning only from the 18 February 1911 eventful flight between Naini and Allahabad of the world's first airmail carriage. Notwithstanding some confusion in terms of times past, the 'concept paper' has listed a series of programmes beginning with series of newspaper advertisements, formulation of a Centenary logo (see), re-adoption of the *Maharaja* as mascot, a Centenary theme song, a grand exhibition at an appropriate location, felicitation of prominent people who have contributed to Indian civil aviation, aero modelling and painting competitions etc.

However the most significant announcement by the Minister was for the establishment of a *National Air & Space Museum,* preferably at the historic Safdarjung Airport. *The Society for Aerospace Studies,* publishers of the *Vayu Aerospace Review,* have been crusading for just such a museum to enshrine India's aviation heritage and so inspire future generations.

In the perspectives pamphlet distributed at the '*Centenary of Aviation in India'* celebrations at New Delhi on 2 December 2010, the Society had suggested "*Where better than at a dedicated area within Safdarjung Airport, the heart of New Delhi and the home of the very first flying club and airport in the country."*

A330 and A320s leased to Indian carriers

Indian carriers are to lease Airbus' eco-efficient A330 and A320 Family aircraft, with Air India taking 10 A330s and 15 A320s and Jet Airways another 10 A330s. The carriers will select an engine supplier and leasing company in the near future, the deals were announced during French President Sarkozy's visit to India on 6 December 2010.

Fabrication of Indian Navy's first P-8I

Boeing has begun fabrication of the Indian Navy's first P-8I long-range maritime reconnaissance and anti-submarine warfare aircraft in Wichita. The P-8I, based on the Boeing Next-Generation 737 commercial airplane, is a variant of the P-8A Poseidon that Boeing is developing for the U.S. Navy.

Employees at Spirit AeroSystems, where all Boeing Next-Generation 737 fuselages, nacelles and pylons are designed and built, cut the P-8I's first part, a bonded aluminium panel that will later be installed on the fuselage's upper lobe to support an antenna. Panels and other fuselage components will come together at Spirit's existing Next-Generation 737 production line. Spirit will later ship the P-8I fuselage to the Boeing Commercial Airplanes facility in Renton, Washington in mid-2011 for final assembly and installation of mission systems and complete testing prior to delivery to the Indian Navy.

"P-8I fuselage sections are designed and built using the same processes we use on the commercial 737," said Mike King, Spirit AeroSystems Fuselage Segment senior vice

president/ general manager. "We've built seven P-8A fuselages to date and continue to increase efficiency as we move forward." Boeing will deliver the first of eight P-8I aircraft to India within 48 months of the original contract signing, which took place in January 2009.

Meanwhile Boeing has received a key sensor for the Indian Navy's P-8I from Bharat Electronics Ltd, which delivered the Indian-designed Identification Friend or Foe Interrogator. Indigenous P-8I deliveries also include BEL's Data Link II communications system, Avantel's mobile satellite system and the Electronic Corporation of India Ltd's speech secrecy system.

Telephonics supply MMR for P-8I Maritime Patrol Aircraft

Telephonics Corporation, a wholly owned subsidiary of Griffon Corporation, will supply APS-143C(V)3 Multi-Mode Radar (MMR) for the Indian Navy's P-8I aircraft through its Radar Systems Division, which includes systems to support (8) P-8i Aft Radar installations integration and support services.

The Telephonics APS-143C(V)3 has become the performance standard in maritime patrol aircraft and multi-mission maritime helicopters. In addition to the aft radar on the P-8I, the APS-143C(V)3 is performing on the USCG HC-144A Maritime Patrol Aircraft and HU-25D Falcon Jet. The APS-143 is featured on most international S-70 Naval Hawk helicopters and certain NH-90, Super Lynx and other Maritime Helicopters.

US notifies sale of Harpoons for Indian P-8Is

The US Defence Security Cooperation Agency (DSCA) has issued a notification to the US Congress for the possible Foreign Military Sale of 21 AGM-84L Harpoon Block II Missiles and associated equipment, parts and logistical support for a complete package worth approximately $200 million.

The DSCA notification also listed as part of the sale, 5 ATM-84L Harpoon Block II Training Missiles, Captive Air Training Missiles, containers, spare and repair parts, support and test equipment, publications and technical documentation, personnel training and training equipment, U.S. Government and contractor representatives technical assistance, engineering and logistics support services and other related elements of logistics support.

While earlier the IAF had acquired 24 Harpoon Block II missiles for its Jaguar aircraft, the DSCA stated that this sale is intended for the P-8I Long Range Maritime Reconnaissance aircraft that the Indian Navy had ordered in January 2009. The prime contractors for this sale will be Boeing and Delex Systems Incorporated.

Saab receives order for coastal surveillance system

Swedish company Saab has received an order from the Indian Maritime Authority DGLL (Directorate General of Lighthouses and Lightships) for supply of a system for coastal surveillance of the entire Indian coast. The system comprises of sensors to be installed along the Indian coast and equipment for regional and national control centres. Users of the system apart from DGLL will be the Indian Navy, Coast Guard and DG Shipping. Saab will implement the project which includes installation, commissioning, training and support together with their Indian partner, Elcome Marine Services, with the project to be completed within 18 months.

Indo-French Bilateral Navy Exercise

Varuna 2010, the bilateral naval exercise between the Indian Navy and the French Navy commenced from 7 January 2011 with aircraft carriers, destroyers, frigates, tankers and submarines from both sides participating. For *Varuna* 2010, the French Navy was represented by ships from the French Carrier Strike Group, designated Task Force 473 and mainly based at Toulon, France. The Task Force included the aircraft carrier FNS *Charles De Gaulle,* destroyers FNS *Forbin* and FNS *Tourville,* supply ship FNS *Meuse* and nuclear powered submarine FNS *Amethyste*. The aircraft carrier *Charles De Gaulle* carried its complement of fighter aircraft, Rafales and Super Etendards, airborne early warning aircraft E-2C Hawkeye and integral helicopters.

The Indian Navy was represented by the aircraft carrier INS *Viraat,* two indigenous frigates INS *Godavari* and INS *Ganga* and one *Shishumar*-class submarine, INS *Shalki.* Sea Harrier fighters, fixed and rotary wing aircraft also participated in the bilateral exercise. The harbour phase was scheduled from 7-10 January 2011 and the sea phase conducted in the Arabian Sea from 11-14 January. "The scope of *Varuna* 2010 includes the entire gamut of maritime operations ranging from Aircraft Carrier Operations, Anti-Submarine Warfare operations and Maritime Interdiction Operations exercises."

Indian Navy, Coast Guard to receive 127 ships in 2010-11

In recent years, the MoD has been able to ensure improved results in the delivery of warships and submarines. During 2009-2010, these numbers stood at 120 vessels for the Indian Navy, Coast Guard and coastal states. In the current financial year, 85 vessels have already been delivered and by March 2011, a total of 127 vessels will be delivered, according to Defence Minister A K Antony.

The government is giving top priority to modernisation of shipyards so that state-of-the-art warships can be built indigenously to global standards in the most transparent manner. He said that in future, "all vessels of the Indian Navy will be built indigenously and the private sector will play a crucial role in this endeavour."

Giving details of the modernisation plans currently being carried out in Mazagon Dock Limited, Garden Reach Shipbuilders and Engineers Limited and Goa Shipyard Limited, Antony said "these include human resource development, important components for upgradation and diversification of ship building infrastructure and implementing state of the art management tools and techniques. He also mentioned that Hindustan Shipyard Limited has been transferred from the Ministry of Shipping to the Department Defence Production and a modernisation programme for HSL will be finalised soon, with the first phase of the modernisation plan to be completed by first half of 2011."

CCS clears 4 more stealth destroyers

The government has cleared another major programme for the Indian Navy, 'Project-15B', to indigenously construct four guided-missile stealth destroyers at Mazagon Docks Limited. Project-15B, which will be undertaken at MDL after the three *Kolkata*-class 6,700 tonne destroyers already being constructed there under long-delayed Rs 11,662-crore project are finally delivered in 2012-2014, is understood to have been cleared by the Cabinet Committee on Security on 8 December 2010 evening, having earlier been cleared by the Defence Acquisitions Council in July 2010.

In its quest to become a powerful three-dimensional blue-water force and maintain a fleet of around 140 surface and sub-surface combatants, the Navy already has 30 warships and six submarines on order at various Indian shipyards. In addition, there is the aircraft carrier *Admiral Gorshkov* (INS *Vikramditya*) three additional *Talwar*-class stealth frigates ordered on Russia, as also two fleet tankers under construction overseas.

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'NIRDESH' R&D Centre established at Chaliyam

Defence Minister AK Antony has laid foundation stone of the National Institute for Research and Development in Defence Shipbuilding (NIRDESH) at Chaliyam, near Kozhikode (Calicut). "Modern Naval platforms are complex and technology intensive and hence it is imperative that the country has the technological base and skill sets within, to design and develop them". NIRDESH is part of the Department of Defence Production and "is expected to shepherd essential self reliance and foster indigenous expertise in naval shipbuilding technology." The Defence Minister pointed out that the setting up of NIRDESH would ensure that the country would be self reliant in this crucial area of defence technology.

Defence Minister AK Antony, speaking during the foundation stone laying ceremony.

'Maitri' missiles in DRDL-MBDA $500-million JV

DRDO's premier missile laboratory - the Defence Research and Development Laboratory (DRDL) - and European missile house MBDA are jointly developing a new-generation low-level, quick-reaction missile (LLQRM) system, known as *Maitri*, for the Indian Navy and Air Force. The Indo-French short-range missile will also be offered to the Army for replacing obsolete SAMs in service. This $500-million project is a joint venture with MBDA, one of the world's largest missile manufacturers.

Brahmos Block III version test fired

Block III version of the Brahmos, with advanced guidance and upgraded software, incorporating high manoeuvres at multiple points and steep dive from high altitude, was flight tested successfully from Launch Complex III at the Integrated Test Range, Chandipur on 2 December 2010. All Telemetry, Tracking stations including naval ships near terminal point confirmed the mission success. The launch was executed from a Mobile Autonomous Launcher by trained Army Personnel. Dr. A Sivathannu Pillai, CC R&D (DRDO) & CEO, MD Brahmos Aerospace confirmed that the mission was successful and described it as a "text book launch".

Agni-1 tested by SFC

A medium range missile Agni-1(A1) was successfully launched from Launch Complex IV (LC-IV) at Wheelers Island off the coast of Bay of Bengal on 25 November 2010, the missile following the trajectory "perfectly" before impacting on the designated target in the Bay of Bengal. Radars, telemetry and electro-optical systems along the coast tracked and monitored all the parameters while ships located near the target witnessed the terminal event successfully. The launch of the A1 missile was carried out by the Strategic Forces Command (SFC) as part of routine exercise.

Rafael's *Iron Dome, David's Sling* offered

Lova Drori, Executive Vice President of Rafael Advanced Defence Systems has confirmed offer of two of its most advanced defensive weapon systems (*Iron Dome* and *David's Sling*), to the Indian Armed Forces. *Iron Dome* is a mobile air defence system in development by Rafael Advanced Defence Systems designed to intercept short-range rockets and artillery shells. The system is being created as a defensive counter-measure to rocket threats against Israel's civilian population and is expected to be deployed by the first quarter of 2011. It is designed to intercept very short-range threats of up to 40 kilometres in all-weather situations.

David's Sling, also sometimes called *Magic Wand,* is an Israel Defence Forces military system being jointly developed by Rafael Advanced Defence Systems and US Raytheon, is designed to intercept medium-to-long range rockets and slower-flying cruise missiles, fired at ranges from 40 km to 300 km.

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Successful launch of Prithvi-IIs

Two Prithvi tactical ballistic missiles were successfully flight tested within one hour time from the ITR at Chandipur in Orissa, the two launches taking place at 08.15 hrs and 09.15 hrs respectively on 22 December 2010. The liquid propelled Prithvi missile has already been inducted into service by the Indian Armed Forces and were test fired by the Strategic Force Command (SFC) as part of regular exercises.

The Prithvi TBMs impacted on the specified targets "with accuracy", the radars, electro-optical tracking systems and telemetry stations along the coast monitoring the trajectory parameters of the vehicle throughout the mission. Observers on a ship located near the target location witnessed the final impact.

DRDO hands over NBC Recce Vehicle to Indian Army

Four NBC (Nuclear, Biological and Chemical) Recce Vehicles were handed over by Dr W Selvamurthy, CCR&D DRDO to Lt Gen MC Badhani, Engineer-in-Chief Indian Army during a flagging-off ceremony held on 21 December 2010 at Bharat Electronics Ltd. (BEL), Pune.

These vehicles, based on the BMP-II, are equipped to monitor radiologically and chemically contaminated areas. Various sensors such as Roentgenometer, Gas Chromatograph, Dosimeter, Solid State Anemometer and Chemical Sensor are integrated on to this vehicle which provides protection to the crew while monitoring for NBC contaminants. These BMP IIKs have been manufactured at Ordnance Factory, Medak while NBC instruments are integrated by BEL at Pune.

New Defence Production and Procurement Policy released

The *Defence Procurement Policy* 2011, released on 6 January 2011, supersedes the earlier DPP-2008 and accepts a key request of foreign as well as Indian vendors in the aviation and homeland security sectors by expanding the existing list of offsettable products to include internal security and civil aircraft. These are adjacent markets to the defence sector with similar products where growth of one has the ability to affect the other. By allowing these products, the confusion which prevailed regarding their acceptance has been removed, besides improving the ability to absorb offset obligations. A number of SMEs which are in the field of homeland security are likely to gain from the new offset policy.

Comprehensive growth of an aerospace industry, related services such as Engineering R&D, MRO and Training also need a boost but although all these have been permitted as offsets since 2007, there has existed an unexplained confusion regarding training services, including simulators. Inclusion of these services has been a demand of the armed forces and DPP 2011 has now formalised these.

Secretary Defence Production R K Singh, with Dr MM Pallam Raju, Minister of State for Defence and A K Antony, the Minister of Defence.

Concerning the new *Defence Production Policy*, the Minister for Defence has stated that this "aims to achieve maximum synergy among the Armed Forces, DPSUs, OFBs, Indian Industry and Research and Development institutions. The Defence Production Policy has been prepared after extensive consultations with various stakeholders such as the three Services, Coast Guard, Integrated Defence Staff, DRDO and Indian Industry Associations – CII, FICCI, ASSOCHAM, etc."

"Under the new Defence Production Policy, which comes into force with immediate effect, preference will be given to indigenous design, development and manufacture of defence equipment. Therefore, wherever the required arms, ammunition and equipment are possible to be made by the Indian industry within the time lines required by the Services, the procurement will be made from the indigenous sources."

SERVICE APPOINTMENTS

Air Marshal NAK Browne is the Vice Chief of Air Staff

Air Marshal NAK Browne assumed charge as the new Vice Chief of the Air Staff (VCAS) at Air Headquarters on 1 January 2011. He was formerly Air Officer Commanding-in-Chief (AOC-in-C) of the Western Air Command (WAC).

Commissioned into the fighter stream of Indian Air Force on 24 June 1972, Air Marshal Browne has varied operational experience and has flown various aircraft that include Hunters, all variants of the MiG-21s, Jaguar and the Su-30K. He is a Fighter Combat Leader who has also served as an instructor at the Tactics and Combat Development Establishment (TACDE) and Defence Services Staff College (DSSC), Wellington. He trained with the Royal Air Force (RAF) in the United Kingdom on Jaguar aircraft and subsequently commanded No.16 Squadron with Jaguars.

A graduate of the Air Command and Staff College, USA, he has held many appointments that include Joint Director at Air War Strategy Cell at Air Headquarters, Chief Operations Officer and Air Officer Commanding of a Su-30 base, Air-I at Western Air Command (WAC) and Assistant Chief of Air Staff (Intelligence) at Air Headquarters. He was also responsible for establishing the Indian Defence Wing in Tel Aviv, Israel in April 1997 where he served as the Defence Attaché till July 2000. From March 2007 to 31 May 2009 he functioned as the Deputy Chief of Air Staff at Air Headquarters, responsible for various IAF's major modernisation programmes before taking over as the Air Officer Commanding-in-Chief (AOC-in-C) of the Western Air Command (WAC).

Air Marshal DC Kumaria is AOC-in-C Western Air Command

Air Marshal DC Kumaria took over as Air Officer Commanding-in-Chief, Western Air Command (WAC) on 1 January 2011. Commissioned as a fighter pilot in the Flying Branch of the Indian Air Force on 2 July 1973, he is a Qualified

Weapon Instructor, having undergone the QWI course in the United Kingdom and a Fighter Combat Leader, who also served as a Directing Staff at the Tactics and Air Combat Development Establishment (TACDE).

His many important Field and Staff appointments include Assistant Advisor (Air) at Indian High Commission in Dhaka, Bangladesh, Defence Attaché at Indian Embassy in Rome (Italy). He has commanded No.6 Squadron with Jaguars specialising in maritime strike role as well as a fighter airbase and has had operational experience flying all versions of MiG-21s. He was Principal Director of Concept Studies at Air Headquarters (Vayu Bhavan), was Air-I at Western Air Command (WAC) and was also selected to write the *Air Power Doctrine* of the Indian Air Force in 1994. He was the first Assistant Chief of Air Staff Operations (Space) and the first Director General Air (Operations) at Air Headquarters. Before taking over Western Air Command, Air Marshal Kumaria was the Senior Air Staff Officer (SASO) at South Western Air Command at Gandhinagar.

Air Marshal AK Gogoi takes over as AOC-in-C, SWAC

Air Marshal Anjan Kumar Gogoi took over as Air Officer Commanding-in-Chief, South Western Air Command

(SWAC) on 1 January 2011. Commissioned as a fighter pilot on 2 June 1973, he has flown over 3000 hours on various aircraft types, is a qualified Flying Instructor and a Fighter Combat Leader. His operational assignments include command of a frontline fighter squadron, Chief Operations Officer of an operational base and command of two premier airbases. His staff appointments include tenures as Assistant Chief of Air Staff (Operations) at Air HQ, Air Defence Commander of SWAC and Director General Air (Operations) at Air HQ.

Air Marshal KJ Mathews is C-in-C SFC

Air Marshal KJ Mathews has taken over as C-in-C of the Strategic Forces Command. He was commissioned as a fighter pilot in the IAF in 1973, is a qualified flying instructor, has flown over 3500 hours in various aircraft types including the HF-24 Marut, MiG-21M and MiG-29, and had a stint with the IAF aerobatic team *Thunderbolts*.

Mathews has commanded two frontline fighter bases and the Air Force Academy at Hyderabad. His staff appointments include Air Defence Officer in WAC, Principal Director of Concept Studies, Air Assistant to Chief of the Air Staff and Assistant Chief of the Air Staff (Ops) at Air Headquarters.

Prior to his present assignment he was Air Officer-in-Charge of Personnel and spearheaded the manpower optimisation process to meet futuristic requirements in anticipation of the induction of modern weapon systems.

Air Marshal Anil Chopra is AOP

Air Marshal Anil Chopra took over on 1 January 2011 as Air Officer-in-Charge Personnel at Air Headquarters. He was commissioned in the flying (pilot) stream of the IAF on 2 June 1973, has had a 37 year operational career with important appointments from Command of No.1 Squadron *(Tigers),* Chief Ops Officer and Air Officer Commanding of a major fighter station. He has flown various types of aircraft including MiG-21s, the Mirage 2000, Su-30, Jaguar, HJT-36, An-32, Avro-748, ALH and Chetak amongst others.

He was team leader of MiG-21bis upgrade team in Russia, Commandant of Aircraft and Systems Testing Establishment, Air Officer Commanding of J&K, ACAS (Inspection) at Air Headquarters and Senior Air Staff Officer at Southern Air Command.

Air Marshal Daljit Singh is DG Air (Ops)

Air Marshal Daljit Singh was commissioned in the fighter stream of the IAF in June 1976 and has flown over 3500 hours on various aircraft which include the Gnat, Ajeet, MiG-21, Su-30MKI and Mirage 2000 aircraft and is a qualified flying instructor.

He has held a variety of operational and staff and operational assignments including command of a No.1 Squadron *(Tigers)*, command of a premier fighter base, ACAS Operations (Air Defence) at Air HQ prior to assuming the post of Director General Air (Operations).

Air Marshal Daljit Singh underwent the specialised Electronic Warfare course on Mirage 2000s at France and has concentrated on EW exploitation.

Vice Admiral DK Joshi takes over as CISC

Vice Admiral Devendra Kumar Joshi took over on 1 January 2011, as the Chief of Integrated Defence Staff to Chairman Chiefs of Staff Committee (CISC) from Air Marshal SC Mukul. Earlier Vice Admiral DK Joshi was Commander in Chief of the Andaman & Nicobar Command and is a specialist in Anti Submarine Warfare.

He has commanded three frontline units in the Western Fleet the Missile Corvette INS *Kuthar*, the *Kashin*-Class Destroyer INS *Ranvir* and the Aircraft Carrier INS *Viraat*. He served as Defence Advisor in Singapore with concurrent accreditation to the Philippines. He was Deputy Chief of Naval Staff from 4 November 2008.

Lieutenant General AS Lamba becomes Vice Chief of Army Staff

Lieutenant General Arvinder Singh Lamba took over as Vice Chief of the Army Staff on 3 December 2010. The General Officer was commissioned into the Regiment of Artillery in June 1971, of which he is the senior Colonel and served with the elite 17 Para Field Regiment.

His command assignments include that of a Rocket Regiment, Mountain Brigade in Counter Insurgency, later an Infantry Division on the Western Sector, and a Strike Corps in the Southern Theatre.

General Lamba was Commander-in-Chief of the Army Training Command at Shimla, prior to this posting with focus on imperative 'Transformation in Training.'

Lieutenant General SK Singh is GOC-in-C South Western Command

Lieutenant General SK Singh who took over as GOC-in-C South Western Command on 1 December 2010 was commissioned in the 8 Gorkha Rifles on 24 December 1972. He has participated in several operations and commanded the brigade on the Siachen glacier during Op *Meghdoot* and later commanded an infantry division in J&K and the 14 Corps in Leh.

He has been instructor in the Infantry School at Mhow, IMTRAT in Bhutan and DSSC in Wellington. He is presently Colonel of the 8 Gorkha Rifles.

Air Marshal PK Roy is Commandant National Defence College

Air Marshal PK Roy has taken over as Commandant of the NDC at New Delhi on 1 January 2011. Commissioned in the IAF in July 1975, he has extensive helicopter flying experience with 4500 hrs and is a qualified flying Instructor.

Appointments previously held by him include command of No.125 Helicopter unit with Mi-25s, Station Commander of the Air Force's highest altitude station at Thoise. He has also held the appointments of Senior Officer in Charge Administration at HQ Eastern Air Command and Assistant Chief of Air Staff (Personnel Airmen and Civilians) at Air Headquarters.

Dr VK Saraswat honoured

Dr Vijay Kumar Saraswat, SA to the RM and Secretary, Department of Defence R&D and DG DRDO was honoured with the *Vikram Sarabhai Memorial Award* at the 98th Indian Science Congress – 2011. The ISC awards were given by Prime Minister Manmohan Singh to twenty seven leading scientists from across the world including two Nobel laureates, during the inaugural ceremony of the ISC 2011. Dr Saraswat dedicated the award to the efforts of entire DRDO fraternity "who have made India proud by developing cutting edge military technologies for the country's defence".

Cover Story

Nearly There

Tejas LCA attains IOC

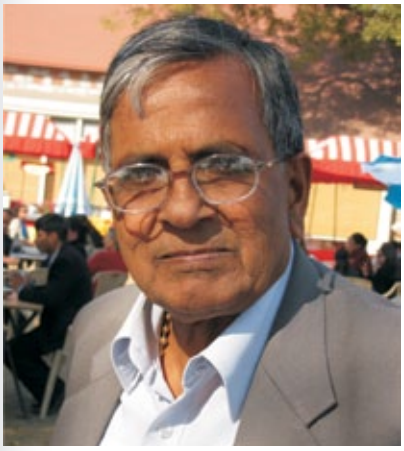
This article for the Vayu is written on 4 January 2011, exactly 10 years after first flight of the LCA Technology Demonstrator-1 (KH 2001), which was piloted by Wing Commander Rajiv Kothiyal. This is a good news story as one has heard all manner of criticisms during the course of the project. As the Light Combat Aircraft, christened Tejas by Prime Minister Atal Bihari Vajpayee in May 2003, is poised to enter service with the Indian Air Force, it is time to look back on major achievements of the project and what it means for the future of military aviation in the country.

Right at the start I must mention several personalities who have made an immense contribution to the success of the project but without any prejudice to the contribution made by the many hundreds of men and women who have laboured long and hard, unsung and unheralded. The first of these personalities is Dr.VS Arunachalam who, as the Scientific Adviser to the Raksha Mantri in the mid-1980s had the vision, even gumption and determination, to go to the Government of India and get the project to build a light weight fighter for the IAF, sanctioned. Neither the IAF nor HAL could have achieved this on their own nor even collectively. His successors, Dr APJ Abdul Kalam, Dr VS Aatre, Mr Natarajan and Dr VK Saraswat (the present SA to RM) have continued to steer the project with competence and most importantly kept the development team insulated from carping criticism from so many quarters. The second personality is "the small man with a big heart", the indefatigable Dr Kota Harinarayana who in the face of daunting technological and managerial

challenges worked like a man possessed for 16 long years till he got the two Technology Demonstrators into the air. The top leadership of the IAF, HAL, DRDO and CSIR has continuously backed the project and provided the necessary resources.

The foremost gain of the project has, undoubtedly, been the closure of three decades of technology gap in several critical areas. The ability to design and Control Law (CLAW) for a fly-by-wire flight control system is a major gain. It would have been a commendable achievement even for a stable aircraft but to successfully develop and flight test it for an unstable delta winged aircraft, is truly praiseworthy. The flight control system required the design and development of a quadruplex digital computer which was done indigenously. The intelligence in the computer in the form of the Control Law and house-keeping software was developed, tested and integrated at ADE. The building of an Iron Bird to test the FCS on the ground and then conducting an exhaustive test programme on it to validate FCS software was an absolute new experience for the CLAW/ADA/HAL team at HAL. In short the country now has the capability to design, test and integrate a complex fly-by-wire flight control system for a fighter aircraft. There is no gainsaying the fact that foreign consultancy played a crucial role in helping the industry to acquire this expertise.

The development of flight safety critical software for the FCS exposed the Indian team to the rigorous methodology which needed to be adopted for such activity. Also for the first time in the industry a process called *Independent Verification and Validation* (IV&V) was adopted to certify the flight safety critical software. In this method a team of software engineers independently verified the coding and testing done by the development team. They then followed the validation procedure adopted on the Iron Bird very closely and pointed out anomalies found in the validation test matrix. The IV&V process greatly reduced the risk in developing flight safety critical software and increased confidence all around. This procedure was subsequently adopted for other national programmes.



Dr Kota Harinarayana is universally regarded as the force behind the Tejas LCA development and, as Programme Director and Chief Designer of Light Combat Aircraft, he successfully directed the project leading to flight testing and clearance for limited series production. His initials (KH) adorn the tail of every LCA.

The LCA test team at the National Flight Testing Centre, Bangalore (L to R) : Lt Cdr A Jain, Wg Cdr S Toffeen, Gp Capt G Thomas, Capt (N) J Maolankar, Air Cmde Rohit Varma, Director NFTC, Wg Cdr (retd) Raveendran, Gp Capt (retd) RR Tyagi, Wg Cdr A Khan, Gp Capt D Chakravorty, Gp Capt Suneet Krishna.

Tejas LCA KH-2012 during its high altitude and sub-zero temperature trials at Leh in December 2008 (see Cover Story in Vayu I/2009).

The development of composite technology for making major airframe assemblies was another first for the aeronautical industry in the country. A state-of-the-art design software to design composite structures was developed in-house at ADA and subsequently sold to Airbus Industrie in Europe! Major parts of an aircraft like the empennage, wings, fin and control surfaces can now be made out of composites in the country.

The development of a full glass cockpit for a fighter aircraft had never before been attempted in India. Glass cockpit technology greatly improves the man machine interface and therefore situational awareness in general and vitally during combat. This technology was a 'must have' for the industry and what was most impressive was that the mission computer hardware and software were developed and tested indigenously. The spin offs from this capability quickly became apparent with the fast development of the mission computers for the Su-30MKI programme as well as the Jaguar and MiG-27 upgrade programmes. For the latter two programmes, the software was also developed in the country.

The development of microprocessor-based monitoring and control systems for general systems on the aircraft like hydraulics, electrics, fuel and environmental control was another gain from the project. This development was done entirely indigenously and will enable future programmes to benefit from this.

The setting up of national teams for development of the control law for the FCS, the composite wings and flight testing was a managerial innovation to harness expertise available with different organisations within the country. The experiment has worked very well and is worthy of adoption in other high technology projects as well.

Flight testing is an activity which is integral to the design and development of any flying machine. The National Flight Test Centre was established in 1994 with personnel drawn from the IAF, ADA and HAL. A modern telemetry station was set up and real time monitoring of all systems on the aircraft was introduced from the very first engine ground run almost three years before the first flight. In the case of a fighter aircraft, flight testing is fraught with a fair amount of risk because of the huge envelope in which the aircraft has

KH-2012 climbs out, its two R-73 CCMs attached.

to operate as well as the variety of stores it has to carry and deliver on a target. In the case of the Tejas LCA, the risk was magnified several fold because four new technologies were flown for the first time in a technology demonstrator aircraft. Testing had to be approached with extreme caution because of the risk to life and aircraft. Here the development of a real time engineering simulator to check out the handling qualities of the Control Law of the FCS proved invaluable. Pilots were able to satisfy themselves that the aircraft could be flown safely in the entire flight envelope. In addition failure states were checked and suitable piloting procedures evolved. Sortie profiles were flown on the ground and problem areas looked at much more closely and in perfect safety. This removed the possibility of the test pilot having to cope with major surprises in the air for the first time. In terms of increasing pilot confidence, this tool was invaluable. For the certification authorities too the simulator proved very useful.

At the NFTC a specialised team of test pilots, flight test engineers, instrumentation and analysis engineers have acquired the knowhow and the knowwhy of conducting a flight test programme for a fourth generation fighter aircraft which has several new technologies incorporated in it. With the help of real time telemetry monitoring the team has been able to ensure safety even during risky phases of flight testing. Though flight testing has been going on in the country for over 50 years this is the first time that a test programme has been monitored with such rigour. The team has also systematically followed up all issues which were uncovered during testing. Effective supervision of each and every aspect of flight testing by the Project Director (Flight Test) at NFTC (always an IAF test pilot on deputation to ADA) has ensured that no safety issue, however small, has been left unattended.

It is worth bringing to the reader's notice an incident which occurred during the technology demonstration phase. During a test sortie, the flight test engineer monitoring the flight noticed the main hydraulic system pressure dropping and alerted the pilot even before cockpit warnings were triggered. As the pilot aborted the test and started turning towards base, the second system pressure also started dropping. Hydraulic fluid was draining out of both systems at a very rapid rate. With commendable presence of mind brought about by his profound knowledge of the system, the test engineer told the pilot to lower the undercarriage immediately because when the fluid level in both systems reached a critical level isolation valves would cut off hydraulic supply to all other services and preserve the remaining fluid exclusively for the flight controls. As the wheels locked down the isolation valves closed and a certain loss of aircraft, because there was no question of attempting a wheels up landing on a concrete runway, was prevented. Thereafter the test pilot brought home the aircraft after experiencing violent nose wheel shimmy on the landing roll for want of hydraulic pressure in the nose wheel steering mechanism. The sideways acceleration experienced during this phase was so severe that the HUD broke from its mounting and fell to one side on the cockpit coaming. It was only the excellent rapport between the pilot and engineer which saved the day. The benefit of real time monitoring by competent personnel was never more apparent.

In the days of yore when flight testing was not so highly developed, flight test data would be used to build mathematical models on the ground. These days with advanced analytical techniques and high quality wind tunnel data, mathematical models are made a priori for various aspects of the aircraft like performance, structural loads and flutter. These models are then validated with flight test data collected at the most critical points in the envelope. This method was adopted for the Tejas and has improved the efficiency of the flight test process.

HAL has been the biggest beneficiary of the Tejas programme. During the technology demonstration phase itself, a significant portion of the allotted budget was spent in developing infrastructure at HAL Divisions. The introduction of Computer Aided Design (CAD) using the Dassault– developed Computer Aided Three Dimensional Interactive Application

Tejas LCA during weapon release trials over Goa.

software (CATIA) was a revolutionary step in 1986. The old drawing board and blue print method was discarded for good! All design data were stored at a master server in ADA and linked to Computer Aided Manufacture (CAM) facilities at HAL shops. In this manner the Numerical Master Geometry (NMG) of the aircraft was preserved in a precise way and the accuracy with which various parts of the aircraft could be made was greatly improved. To be sure, these methods had been adopted by the advanced aerospace countries a decade earlier but for India it was a significant step towards bridging the design and manufacturing technology gap. As an aside I must mention that Mr Ratan Tata during his visit to ADA in 1991 was so impressed by the CATIA software that he immediately ordered its use for design and development of the Indica car. This is just one example of how Indian industry has benefited from the Tejas programme.

The first two-seater Tejas LCA PV-5 (KH-T2009).

Trio of LCAs at INS Hansa, Dabolim (Goa) during the penultimate stage of trials before the aircraft was to be "released to service".

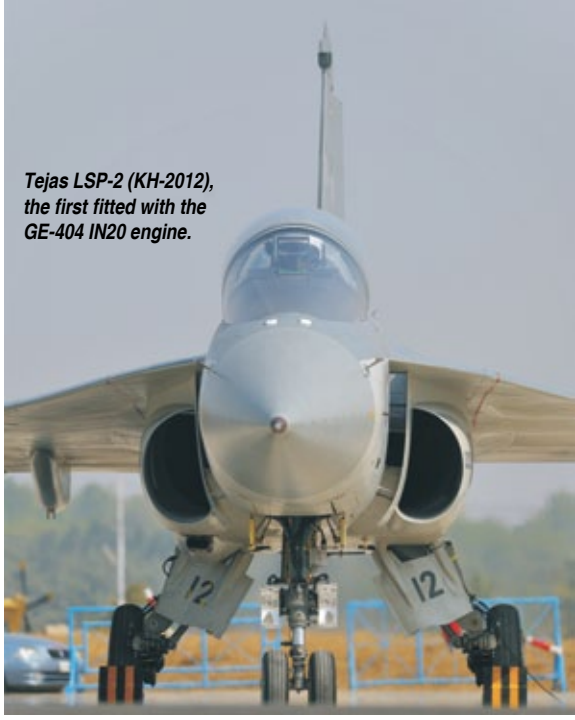
The establishment of numerous test rigs at the prototype shops of the Design Bureau of HAL has exposed the workforce to the use of these rigs for testing and validation of their designs before trying them out on the aircraft. Rigs for testing the Flight Control System (Iron Bird), rig for structural strength test of a half wing (Major Airframe Structural Test - MAST), brake testing dynamometer, fuel system test rig, undercarriage drop test rig and many others were set up using Tejas funds. The development of the knowledge and skills of the workforce at the Design Bureau has done wonders to the confidence of both the engineers and technicians. The immediate spin off of the decade-long upgradation of skills that took place at HAL, was the remarkable achievement of flying the Intermediate Jet Trainer prototype in March 2003, just 22 months after metal was cut for the first time. As HAL looks forward to working with Russian aerospace designers on the

Tejas LCA prototype vehicle-3 (KH-2005) with drop tanks before sortie at HAL Bangalore.

T-50 fifth generation fighter project and the Medium Transport Aircraft (MTA) project in the years ahead, the two decades spent in design and development of the Tejas will prove extremely useful. This is because the designers will able to interact with their counterparts on a credible footing and thereby greatly improve their ability to absorb new ideas, methods and technologies from the Russians.

HAL, however, has to further improve production technology currently in use to produce the Tejas. Quality of manufacture has to be improved considerably if the IAF is not to face serviceability and other maintenance problems in the field. The rate of production must also be ramped up so that the IAF is able to form two squadrons of Tejas Mk.1s in the next four years. Product support for the Tejas fleet in the field will have to be provided only by HAL because as far as the IAF is concerned, HAL has been contracted to deliver the aircraft - and not ADA/DRDO. The effort put in by thousands of men and women over a long period of time will be wasted if these three aspects are not paid immediate attention at the highest level.

The Tejas LCA project has harnessed the capabilities available in the private sector in the country in a big way. A network of ancillary industries has been formed to support aerospace activities in the country in the future. This is another very important fallout of the programme.



Tejas LSP-2 (KH-2012), the first fitted with the GE-404 IN20 engine.

Clean lines of the LCA seen to good effect.

The Centre for Military Airworthiness and Certification (CEMILAC) has gained valuable experience in certifying a fourth generation fighter. This experience will stand it in good stead during the T.50 programme. The constant surveillance carried out by the organisation over all design activities made designers carry out their work with the utmost diligence. The contribution made by CEMILAC to flight safety has been very significant and is readily acknowledged by the designers and flight test personnel.

All the major players in the programme, ADA, DRDO, HAL, CSIR and the IAF, have learnt that managing a complex aeronautical project is not easily done. It is time consuming and requires a long

Tejas with Sea Harrier at INS Hansa, Goa: KH-2014, being the fourth of the limited series production aircraft (LSP-4) was the first aircraft flown in the configuration to be delivered to the Indian Air Force. This aircraft has the hybrid multi-mode radar and an IFF system installed.

DRDO

PV-3 (KH-2005), the first production variant takes off with underwing stores including drop tanks and free fall bombs.

term commitment of financial and human resources. Continuity of personnel working in the programme has to be ensured. Everyone has to pull in the same direction if success is to be achieved. Specifications should not be changed unless absolutely necessary and early intervention is better than late intervention. Changes relating to carriage and release of new weapons must be initiated well in time.

When this article is published, the Defence Minister Shri AK Antony would have handed over documents to the Chief of the Air Staff, Air Chief Marshal PV Naik, certifying that the aircraft was ready for induction into the IAF, albeit with limited operationally capability. This is a defining moment for a resurgent aeronautical industry in India which is poised to scale great heights of achievement over the next two decades. The Tejas LCA programme will be credited as the catalyst that made it all possible.

Air Marshal (R) Philip R Rajkumar

The Tejas glass cockpit.

After the first successful missile launch at Goa from LCA PV-1 (KH-2003). The pilot was Gp Capt Harish, standing next to whom is Air Cmde RKS Bhaduria and JJ Jadhav, Sc 'G' at ADA. Gathered around are personnel from ADA and HAL.

GE

The M-MRCA stakes

Heartening as it is that the IAF is acquiring more multi-role fighter aircraft in the near future, is the fact that even these may not be enough to fulfil the needs of the Force. There has been a serious depletion of force levels over the years. Way back in 1963, the government had decided that the IAF would have 64 combat squadrons, which means about 1280 aircraft. This figure was decided in view of the security scenario on the western and north-eastern borders. The number of squadrons was later tapered down to 45. This was on the basis of requirements four decades ago. The need has increased considerably following the acquisition of modern aircraft by China as well as Pakistan. And yet, the IAF today is down to just 30 squadrons! Defence analysts point out that if two or three squadrons are phased out every year without immediate replacements, the IAF inventory could go down to about 24 squadrons by 2015 or just about the same as the Pakistan Air Force (PAF) would have then.

Of course, cost is a major factor. Fighter aircraft are prohibitively expensive. But that is not the only reason why the IAF has been falling back. Inertia had set in after various defence scandals. Things are now changing slowly but in defence matters one has to plan years - if not decades - ahead. India was also done in by the inordinately long delay in the AJT programme which resulted in far too many accidents with tragic loss of lives apart from the extremely expensive hardware. The LCA programme has been a protracted one and the first squadron will achieve FOC only in 2014 or thereabouts.

All these drawbacks will have to be taken into account to make sure that the country's defence preparedness is not compromised. Of the long list, the biggest malaise is politics. Defence acquisitions should not be allowed to get caught in red tape. All other organs of the body politic have been affected by this chronic disease. At least the fighting arm should be given the mandatory immunity shots.

The Eurofighter Typhoon, a fourth generation aircraft powered by two EJ200 turbofan engines is currently optimised for the air-air role through its performance characteristics and what is by all accounts an excellent pilot interface.

The above 'appeal' is cloned from an editorial in 'The Tribune' of 8 October 2004 (Air Force Day), over six years back when the Government first issued the 'Request for Information' to four short listed companies for their fighters to meet the IAF's medium-multi role combat aircraft ASR. As 2011 dawns, there is still no sign of when the M-MRCA decision will be taken even as the original four candidate aircraft types have been augmented by another three (though Dassault have replaced their Mirage 2000-5 with the Rafale new generation fighter). The other five are Lockheed Martin's F-16IN Super Viper, Saab's Gripen IN, Boeing's F/A-18 Super Hornet, the Eurofighter Typhoon and MiG-35.

So what is the situation today?

In July 2010, the IAF completed its evaluation report following the field

– seven years on!

The Boeing F/A-18 A-D Super Hornet, powered by GE F 414 engines has the AN/APG-79 AESA radar. Other advantages include carrier capability and a very wide range of integrated weapons.

trials for the six fighters. The trials were conducted at Bangalore, Leh and Jaisalmer to test the various aircraft under extremely wet, cold and hot conditions respectively, typical of the Indian environment. These also included weapons release, technical and maintainability evaluations. The evaluation report was then submitted to the Ministry of Defence (MoD) where it would eventually be discussed by the Cabinet Committee on Security (CCS), after which the process of awarding the contract would be initiated. Once the MoD finalises the short listed types, the complex process of negotiations would begin leading to awarding of the deal to the winner, which, according to the various sources, is likely to be sometime in late 2011.

The Dassault Rafale, powered by two Snecma M88-2 engines, offers superior aerodynamic performance and its Rafale-M version is operational on board the French aircraft carrier, which could be an added advantage.

Subsequently, delivery of the first aircraft is to start within 36 months of contract signing and completed 48 months later. Of the 126 aircraft India aims to procure, 18 would be in 'flyaway' condition and 106 would be produced locally under license through technology transfer. The M-MRCAs are being procured to replace the ageing MiG-21 and the now retired MiG-23 fleet of the IAF. All six fighter types in contention are to be equipped with state-of-the-art avionics and AESA (Active Electronically Scanned Array) airborne radar. There is also little difference in their ordnance and where needed, changes/ modifications should be possible.

Currently, the companies' industrial offsets proposals are being evaluated, with technology transfers to come next. Only when this process produces a short list will their commercial offers be evaluated. The downselect is expected to eliminate two or three of the six initial candidates, but nothing is for definite. Companies, who were supposed to have their evaluations completed in April 2010, were required to extend or revise their bids until April 2011.

If the MoD is still not able to complete its downselect process by then, the companies will have to resubmit their bids and another year's delay will be inevitable, which raises the prospect that volatile financial markets might cause swings in currency rates that could change the value of the range of highest to lowest bidders significantly, given that rates are determined not when bids are received but when the commercial evaluation begins. There could be hold-ups on the terms for technology transfer, which must be completed with the main contract. India requires that licensed production of the aircraft—including engines, accessories, radars, systems and tooling—be covered by the tech-transfer proposal. The MoD holds refusal rights on any specific item, and suppliers must provide full life-cycle product support.

Back to the Offsets imbroglio

In September 2010, the companies were invited to a review of their offset proposals by MoD, but were informed that the proposals submitted by them failed to comply with the parameters set by the MoD. They were also informed that in the case of offsets for third party suppliers, all companies would need to have Memoranda of Understanding (MoU) in place with their suppliers' suppliers as well, and that a letter to this effect would be issued "shortly", which would also list discrepancies in the offset proposals of the respective companies.

Although no such letter was forthcoming, representatives of all six companies were invited to a meeting in December 2010, where they were again informed of their non-compliance with the offset requirements. They were also told that they would be issued letters listing out the discrepancies in their offset proposals, as well as the structure of the MOUs required to be in place with Indian sub-contractors to the suppliers of the prime companies, on the basis of which, they would have to submit fresh offset proposals by 7 January 2011. Although no letter arrived by November-end, the companies did receive telephone calls advising them that the deadline for resubmission of offset proposals was extended to 21 January 2011.

The Lockheed Martin F-16IN is described as "the most advanced and capable F-16 ever", based on the F-16E/F Block 60 as supplied to the UAE and featuring AN/APG-80 active electronically scanned array (AESA) radar.

Diehl

While the enormity of the MoD's task in evaluating the individual offset proposals, said to number in their hundreds, is understood, it still is difficult to comprehend why this process could not have been conducted in parallel with the flight evaluation trials, since the original offset proposals were submitted in July, 2008!

The MoD, on its part, wants to be "thorough" in setting the offset norms for the companies in the fray for the M-MRCA tender, since this deal, worth over US $10 billion, is expected to lay down the ground rules for offsets for successive deals as well. Most companies object to the idea of signing MoUs with third party contractors since they do not expect to have any direct dealings with them and would prefer to conclude sub-contracts on the basis of bids to obtain the best prices and products and services - if and when they are selected.

In the light of the approval granted to the new *Defence Procurement Procedure* (2011) and an unprecedented *Defence Production Policy* by the Defence Acquisitions Council (DAC), there is a chance that newer offset policy elements might find their way into the norms being set for the M-MRCA companies, even though technically, the M-MRCA tender process is governed by the DPP issued in 2006. In fact, there is now even talk of banking offsets being allowed for the M-MRCA tender, which were actually first permitted by the DPP issued in 2008 under the Defence Offsets Policy.

Another issue that is expected to lead to yet more delays in the process is the failure on the part of the MoD to form a team to evaluate the respective proposals made by companies for the transfer of technology. The methodology for evaluating and comparing the value of the respective proposals for transfer of technology also remains unformulated and unclear. This process, too, is expected to be tedious and time-consuming.

Since the second week of February 2011 will also feature the *Aero India 2011 Show* at Bangalore, these issues are unlikely to see any resolution anytime soon, without which the process cannot proceed toward the formulation of a shortlist of the aircraft and the opening of indicated commercial bids.

In anticipation!

Even as the Medium Multi-Role Combat Aircraft competition has entered the decision phase, Hindustan Aeronautics Limited is planning to set up a large aero structures unit at their Bangalore Complex to take advantage of the possible offsets business arising out of the $10 billion deal. Irrespective of whichever company wins the M-MRCA bid, they will have to partner with HAL to licence-manufacture the aircraft in India and are certain to select HAL as the offsets partner as well.

The Saab Gripen IN next generation multi-role combat aircraft has evolved from the Gripen C, is powered by a GE F414 turbofan engine and described as "a true 4+ generation lightweight fighter and significantly more capable than category competitors".

Gripen

The RAC-MiG-35 is evolved from the MiG-29 to include improved radar and avionics that give it multi-role capability with extra fuel in a new aircraft "spine" plus thrust-vectoring engines.

"Lost and Found"

Even as the intense international competition for the "mother of all defence deals" enters the last lap, two IAS (Indian Administrative Service) officers of the MoD are now under the scanner for the mysterious way in which a "secret" offsets file entrusted to them went missing from South Block and was then "found" by a roadside near Khelgaon Marg in South Delhi.

Ordering an inquiry into the episode, Defence Minister A K Antony said that he was "very clear that every officer has to be very careful at every stage" while dealing with the huge M-MRCA (medium multi-role combat aircraft) project. "We have viewed the incident seriously…the inquiry is in progress," he said.

The file had been sent by the IAF to the Ministry of Defence for progress and the curious case of 'lost and found' took place at a time when the negotiations on the crucial aspect of offsets were going on. As the file belongs to the IAF, its probe is examining as to how the file went missing from the MoD and since recovered by the IAF.

Predictably, this incident has provoked intense comments and speculation in the media. For instance, ToI reports that even though there are only 6 contenders, the number of lobbyists, sub-contractors and foreign embassy officials involved would have led to at least 100 copies of the report having been "sold" by various bureaucrats with access to the file. The value of such reports goes down sharply with time. It must have been at its most expensive immediately after it was submitted to government and before the many visits by various heads of state to New Delhi.

The depressing part is that nobody is probably very bothered by this episode since the leakage of the report to the contenders is part of the game and already taken into consideration by the Government. In fact leakage of "perceived weaknesses" to a supplier is one of the best buying strategies to extract improvements in the supplier's offer!

HAL's Director for Corporate Planning and Marketing, P. Soundara Rajan has confirmed that a memorandum of understanding had been signed with all the M-MRCA bidders: Boeing, Lockheed Martin, Dassault, Saab, Eurofighter and RAC-MiG as a possible offsets partner to meet bulk of the 50% offsets arising out of the contract. The aero structures unit would meet the export opportunities of the offsets work. HAL also expects to supply different systems designed and manufactured in HAL's various divisions such as Hyderabad, Lucknow and Korwa against offsets.

HAL has extensive experience in aero structures, dealing with international aerospace companies such as Airbus, Boeing, Ruag, IAI and Embraer, which have also been sourcing aero structures from HAL for some years now. Most of the contracts with these companies were entered into when there was no offsets obligations, Soundara Rajan noted. Recognising HAL's capability in timely and cost effective aerospace quality supplies, Boeing has recently conferred upon HAL the "Supplier of the year" award, he added.

With inputs from:
www.Indian-military.org
www.defenseworld.net

Dassault

STAR WARS

Leader of the Pack: the F-22 Raptor.

Fifth generation jet fighters

Under the system of combat aircraft classification which is devised and used by US officials, **Fifth Generation jet fighters** are "the newest and most advanced fighter aircraft, designed to incorporate numerous technological advancements over the class similarly dubbed Fourth generation."

Fifth Generation Fighters are thus unique and revolutionary in that they are designed from the beginning to integrate an array of technologies for the first time into a single platform. Advanced stealth, fighter agility, integrated information and sensor fusion, plus a new level of reliability, maintainability and deployability - all are uniquely found in such fighters. This includes all-aspect stealth even when armed, Low Probability of Intercept Radar (LPIR), high performance airframes, advanced avionics features, and highly integrated computer systems capable of networking with other elements within the theatre of war in order to achieve an advantage in situational awareness. The only currently combat-ready fifth generation fighter, the Lockheed Martin F-22 Raptor, entered service with the U.S. Air Force in 2005.

In fact, Lockheed Martin uses *fifth generation fighter* to describe its F-22 and F-35 fighters, with the definition including "advanced stealth", "extreme performance", "information fusion" and "advanced sustainment". Very low observable stealth was designed into the F-35 and F-22 from the very beginning and is not something that can be added onto a legacy platform. Stealth-defining designs require upfront integration of shape, materials and propulsion, coupled with the internal integration of weapons, fuel, avionics and sensors. The result is a very low observable platform even when fully configured for combat. Their definition does not include supercruise capability, which has typically been associated with the more advanced modern fighters–and which the F-35 Lightning II lacks.

Stealth was first introduced with the F-117 Nighthawk. Designed to attack alone and at night, it revolutionised precision strike capability in lethal environments. Yet it lacked manoeuvrability and was not a multi-role platform. Today's 5th generation fighters bring advanced stealth to the light of day and it is stealth that enables 24x7 operations in any environment, against any known threat extant.

Subsonic, supersonic, high g's, quick acceleration even when loaded with air-to-air and air-to-ground weapons, the F-22 Raptor is a true air-superiority fighter while still incorporating unmatched VLO stealth signatures. The F-22, with its unique features of high-altitude supercruise and thrust-vectoring, surpasses any fighter today.

The F-35 and F-22 also feature unrivalled integration of advanced avionics, which fuses information to give pilots complete 360-degree situational awareness. This enables pilots to concentrate on tactics as they are relieved of the effort to interpret separate data inputs and manage multiple sensors. Furthermore, information gathered by these onboard sensors can also be immediately uplinked and shared with commanders at sea, in the air or on the ground, providing an instant, complete view of ongoing operations.

Lockheed Martin has actually attempted to trademark the term "5th generation fighters" in association with jet aircraft and structural parts thereof and has a trademark to a logo with the term! This use of the term "fifth generation fighter" has been in turn criticised by companies whose products do not conform to these particular specifications, such as Boeing and Eurofighter.

The United States Navy and Boeing have placed the Boeing F/A-18E/F Super Hornet in a "next generation" fighter category along with the F-22 and F-35, as the Super Hornet has a 'fifth generation' AESA radar, modest RCS reductions

UAC

and sensor fusion. A senior USAF pilot has however complained about fifth generation claims for the Super Hornet stating that "The whole point to fifth generation is the synergy of stealth, fusion and complete situational awareness. The point about fifth generation aircraft is that they can do their mission anywhere, even in sophisticated integrated air defence [IADS] environments. If you fly into heavy IADS with a great radar and sensor fusion, but no stealth, you will have complete situational awareness of the guy that kills you!" Still Michael 'Ponch' Garcia of Raytheon opines that the addition of his company's AESA radars to the Super Hornet provides "90 percent of fifth-generation capability at half the cost."

5th generation fighters are designed as significantly more reliable, maintainable and deployable than the fighters they replace. Upfront design emphasis has been placed on supportable advanced stealth, systems reliability and maintainability, onboard systems diagnostics and health monitoring, reduced support equipment, intelligent support systems, paperless technical support and worldwide supply chain management. With a smaller deployment footprint, 5th generation fighters use half the airlift to deploy and operate and expose fewer personnel to risk. Such capabilities result in less force required, less total ownership cost and more expeditionary capability.

Leader of the pack: the F-22 Raptor

The Lockheed Martin/Boeing F-22 Raptor is a single-seat, twin-engine fifth-generation 'supermanoeuvrable' fighter aircraft with stealth technology. It was primarily designed as an air superiority fighter, but has additional capabilities that include ground attack, electronic warfare, and signals intelligence roles. Lockheed Martin Aeronautics is the prime contractor and responsible for the majority of the airframe, weapon systems and final assembly of the F-22. Programme partner Boeing Defence, Space & Security provides the wings, aft fuselage, avionics integration, and all of the pilot and maintenance training systems.

The aircraft was also designated as the F/A-22 during the years prior to formally entering USAF service in December 2005 as the F-22A. Despite a protracted and costly development period, the United States Air Force considers the F-22 as a critical component for the future of US tactical air power and claims that the aircraft is "unmatched by any known or projected fighter", while Lockheed Martin claims that the Raptor's combination of stealth, speed, agility, precision and situational awareness, combined with air-to-air and air-to-ground combat capabilities, makes it by far the best overall fighter in the world today. No opportunity for export currently exists because the export sale of the F-22 is barred by American federal law. Most current customers for U.S. fighters are either acquiring earlier designs like the F-15, F-16, and F/A-18E/F Super Hornet, or else are waiting to acquire the F-35 Lightning II (Joint Strike Fighter), which includes technology from the F-22 but is designed to be cheaper, more flexible, and available for export from the start. The F-35 will not be as nimble as the F-22 or fly as high or as fast, but its radar and avionics will be more advanced.

Other NG Projects

In the late 1980s, the Soviet Union outlined a need for a next-generation aircraft to replace '4th generation' fighter aircraft, the MiG-29 and Su-27 in frontline service. Two projects were proposed to meet this need, so-called '4.5 generation' fighter aircraft, the Su-47 and the MiG 1.44 (although the modernised MiG-35 was also classified as a 4.5 generation fighter).

Sukhoi T-50 PAKFA in flight.

F-35B begins descending to perform vertical landing.

In 2002, Sukhoi was selected to lead the design for the new combat aircraft. The resultant 5th generation fighter aircraft, Sukhoi's PAK FA (T-50) will incorporate technology from both the Su-47 and the MiG 1.44 and when fully developed is intended to replace the MiG-29 and Su-27 in Russian inventory and serve as the

basis of the Sukhoi/HAL FGFA project being co-developed with India. This fifth generation fighter is designed to directly compete with the American F-22 Raptor and American/British F-35 Lightning II. The Sukhoi PAKFA made its maiden flight on 29 January 2010 (See *Vayu* I/2010). Russia is now also developing a new stealth lightweight multi-role fighter, the MiG-LMFS (aka Projekt 1.27, MiG 1.27) based on the cancelled MiG 1.44.

In December 2010, the Government of India signed a mega deal with Russia to jointly develop and produce "a variant of the T-50 fifth generation fighter". While India is hoping that deliveries will start by 2017, the induction date could well go into the next decade. India is also developing its own Next Generation fighter, the Advanced Medium Combat Aircraft (ACA), a twin-engined new generation stealth multi-role fighter. The main role of this aircraft is purportedly to replace the Sepecat Jaguar & Dassault Mirage 2000.

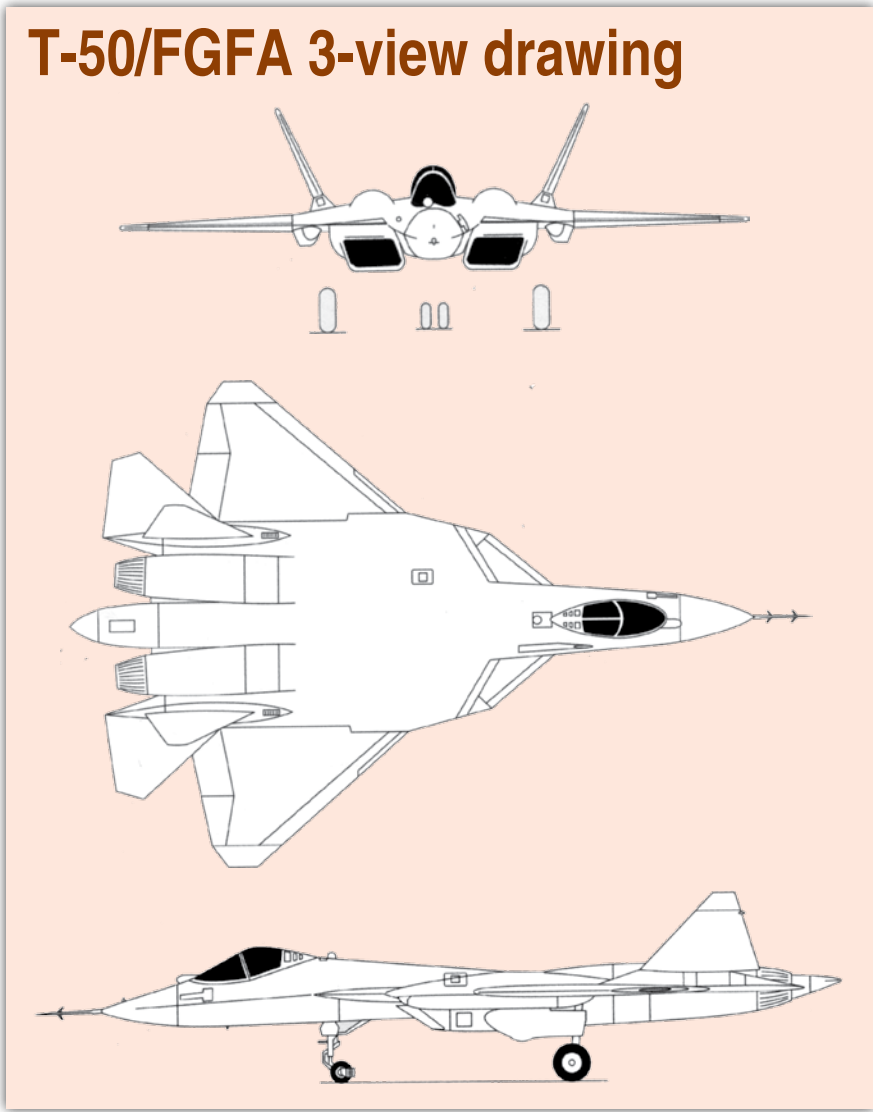
On a cold morning in Siberia are seen the Sukhoi T-50 PAKFA and the Su-27UB chase plane.

Sukhoi/HAL Fifth Generation Fighter Aircraft (T-50/FGFA)

For the Indian Air Force, this derivative project from the PAKFA (T-50) as being developed (FGFA is the official designation for the Indian version) will be a twin-seater, analogous to the Su-30MKI which is a twin seat variant of the baseline Su-27. A total of 500 aircraft are planned with options for further aircraft, of which the Indian Air Force is to get 250-300 FGFAs. India will eventually spend over $25 billion on this project, including design and development, production and procurement costs.

As developed by Sukhoi OKB for the Russian Air Force, the PAKFA, when fully developed, is intended to

Peking Duck? An artist's impression of what the J-20 could have looked like – before the real thing was revealed!!



replace the MiG-29 and Su-27 in Russian inventory. The Russian Air Force has tentatively ordered 200 single seat and 50 twin-seat PAKFAs which are expected to have a service life of about 30–35 years.

Differences between the PAKFA and FGFA

Any difference between the PAKFA and the FGFA must be seen as somewhat similar to that between the Su-27 and Su-30MKI. The Su-27 is the standard Russian version, whereas the Su-30MKI (*'Modernisirovannyi Kommercheskiy Indiski'* meaning "Modernised Commercial India") was specifically developed for the Indian Air Force. The Su-30MKI incorporates Thrust Vectoring Control (TVC) and has canards. It is equipped with a multi-national avionics complex sourced from India, Israel, Russia and France. The PAKFA and the FGFA will of course have common technology. The FGFA will predominantly use weapons of various origins including the Astra, a BVR missile being developed by India. The Indian FGFA is significantly different from the Russian PAKFA because a second pilot means the addition of another dimension, development of wings and control surfaces with some inevitable compromises on stealth features.

Designing the FGFA

Although there is no clarity on the PAK FA and FGFA specifications as yet, it is gathered that this will be stealthy, have the ability to supercruise, be equipped with the next generation of air-to-air, air-to-surface, and air-to-ship missiles and incorporate an AESA radar. The FGFA will initially be powered by 2 Saturn 117S engines (about 14.5 ton thrust each). The 117S is an advanced version of the AL-31F, but built with the experience gained in the AL-41F programme. The AL-41F powered the Mikoyan MFI fighter (Mikoyan Project 1.44). Later versions of the PAK FA will use a completely new engine (17.5 ton thrust each), being developed by NPO Saturn or FGUP MMPP Salyut. Three Russian companies will compete to provide the engines with the final version to be delivered in 2015-2016.

Now enters the Dragon (aka J-20 or *Black Silk*) from China! Variously referred to as the J-XX by western sources, this enigmatic fighter will enter service between 2017-2019 (see following article).

Assumed speecifications of the T-50 / PAKFA / FGFA

- **Length:** 22.0 m (72 ft 2 in)
- **Wingspan:** 14.2 m (46 ft 7 in)
- **Height:** 6.05 m (19 ft 10 in)
- **Wing area:** 78.8 m² (848 ft²)
- **Empty weight:** 18,500 kg (40,786 lb)
- **Loaded weight:** 26,000 kg (57,320 lb)
- **Useful load:** 7,500 kg (16,535 lb)
- **Max takeoff weight:** 37,000 kg (81,571 lb)
- **Powerplant:** 2× Saturn-Lyulka AL-41F turbofans
    - **with dry thrust of** 96.1 kN (9,800 kgf, 21,605 lbf) each
    - **Thrust with afterburner** 152 kN (15,500 kgf, 34,172 lbf) each

Performance

- **Maximum speed:** 2,100 km/h (Mach 2) (1,305 mph)
- **g-limits:** (10+ g)
- **Cruise speed:** 1,300 km/h (800 mph)
- **Ferry range:** 5,500 km (3,400 mi)
- **Service ceiling:** 20,000 m (65,617 ft)
- **Rate of climb:** 350 m/s (68,898 ft/min)
- **Wing loading:** 330(normal) - 470(maximum) kg/m2 (67(normal) - 96(maximum) lb/ft2)
- **Thrust/weight:** 1.19 [24]
- **Runway:** 350 m (1,148 ft)
- **Endurance:** 3.3 hrs (198 mins)

Armament

- **Cannon:** 2× 30 mm internal
- **Hardpoints:** 16 total, 8 internal, 8 on wings.

The largest type of armament likely to be carried by the PAK FA are long-range air-to-air missiles, probably of '810' type (4.2m [13ft 9in] long), multipurpose air-to-ground missiles such as the Kh-38M (4.2m [13ft 9in] long, weighing 520kg (1,146lb) and the Kh-58UShK (4.2m [13ft 9in] long, weighing 650kg (1,433lb) anti-radar missile. Each of the T-50's weapon bays is estimated as 4.6 to 4.7m (15ft 1in to 15ft 5in) long and 1 to 1.1m (3ft 3in to 3ft 7in) wide; two '810' Kh-38M or Kh-58UShK missiles can be placed inside one bay. Other armament types, such as K-77M medium-range air-to-air missiles, Kh-36 anti-radar missiles, 250kg (551lb) and 500kg (1,102lb) guided bombs, with smaller dimensions can be placed in the bay. A single, but similar, weapon bay with two ejector-racks arranged side-by-side was fitted to the Su-47 Berkut experimental fighter when it began flying in the summer of 2007.

Radar

N050 BRLS AESA/PESA
(Enhancement of IRBIS-E) on Su-35

- **Frequency:** X (8 - 12 GHz)
- **Diameter:** 0.7 m (2 ft 4 in)
- **Targets:** 32 tracked, 8 engaged
- **Range:** > 400 km (248 mi)
    - **EPR:** 3 m² (32.3 ft²) at 400 km (248 mi)
    - **RCS:** 3 m ² to 400 km, 1 m ² to 300 km, 0.5 m ² to 240 km, 0.1m ² to 165 km, 0.01m² to 90 km.
    - **Azimuth:** 240 ° (± 120 °)
- **Power:** 5,000 W
- **Weight:** 65 to 80 kg (143 to 176 lb)

"Year of the Tiger"

Almost nonchalantly parked alongside J-10s, is the J-20 (nearest camera).

The Chinese J-20 next generation fighter

What a start to the new year for China, known as the 'Year of the Tiger'! On 11 January 2011 Chinese President Hu Jintao confirmed that its aircraft industry had carried out the first test-flight of its 'fifth-generation stealth fighter'. In fact, this was intriguingly timed during the on-going talks with visiting U.S. Defence Secretary Robert Gates. The prototype J-20 stealth fighter (*Black Silk*) made the maiden flight at around 1300 hours, according to information posted by Chinese aviation enthusiasts on websites. The J-20 was escorted by two J-10 fighters as chase aircraft during the 20-minutes it was airborne.

Almost immediately, observers began to compare the J-20 with the American F-22 Raptor as also the Indo-Russian T-50 (or PAKFA), although imagery and video footage thereafter appearing on the Internet suggests the Chinese model is larger. This could be interpreted as the J-20 being capable of flying a longer range and carrying a heavier load.

"The J-20 appears to be either a demonstrator or a prototype of a combat aircraft with low observable characteristics, particularly in the front quadrant," suggested Douglas Barrie, a senior fellow for military aerospace with the *International Institute for Strategic Studies*. China has been working on a future fighter programme since the mid-1990s (see *Vayu* V/2001, nearly ten years back), and the J-20 is notionally anticipated to enter service around 2018-2020, he added. The design, particularly the rear section and in plan-form is reminiscent of the RAC-MiG 1.42 fighter project which was in competition with the Sukhoi design bureau's T-50 but the MiG programme was discontinued in the latter half of the 1990s after the Sukhoi design was selected.

In fact, there are several suggestions that the Chinese "borrowed" extensively from the 1.42 Project for their own J-20 as indeed was earlier suggested that the Sino-Pak JF-17 Thunder had antecedents in the RAC-MiG design based on the original Indian LCA specifications of the early 1980s.

Variously labelled as the J-14, J-20, J-XX and other nomenclature, the new Chinese fighter was first seen performing high-speed taxi trials within view of public passers-by. This was perhaps an attempt at international transparency or even a tantalising 'teaser-trailer' for the Chinese public, increasingly proud of its emerging military might, disclosure of the existence of a new generation fighter, a roaring revelation in the 'Year of the Tiger'.

Deputy Commander General of the People's Liberation Army Air Force (PLAAF), He Weirong, had earlier announced on 8 December 2010 that China's 'fourth-generation fighter' (considered fifth-generation in the West) would fly "soon" and that it would enter service in "8 to 10 years". Just before the PLA Navy's 60th anniversary last April, PLA Navy Commander Admiral Wu Shengli gave a speech in which he outlined future requirements as including a fighter capable of "supersonic cruise".

It has long been expected that China's next-generation fighter would be capable of supercruise, use stealth technology, and have advanced electronic systems like active electronically scanned array radar and use thrust vectoring to achieve high post-stall manoeuvrability. The photographs initially started appearing on Chinese websites, but were doubted as being fakes as they were low resolution and grainy. However, several clearer images thereafter appeared on various Chinese sites - so this is for real!

However, real success for China's 5th generation fighter will depend greatly on indigenous development of advanced turbofan engines capable of near or greater than 10-to-1 thrust to weight ratios. Engine technology has been a longstanding weakness for China's aerospace industry, but China has also devoted great resources to this sector. After considerable difficulty, the Shenyang Engine Group-led 12-to-13-ton thrust WS-10A '4th generation' turbofan is now entering production. While the Shenyang Engine group may have a 15-ton version of this engine in development, the Chengdu Engine Group would be leading development of the WS-15, a 15+ ton thrust engine. In late 2009, a Russian source speculated that China has a 18-ton thrust engine programme underway, which would be comparable to the Pratt Whitney F135 engine that powers the Lockheed-Martin F-35. In August 2009, Ukrainian sources mentioned that the Motor Sich concern was pursuing an engine co-development programme with China that would result in a second 15-ton class fighter engine. Supporting this, Chinese sources have suggested that Motor Sich would be co-operating with an engine design bureau associated with the Chengdu design organisation.

Air Dominance

Saab Gripen of the Swedish Air Force dispensing countermeasure flares (Photo: Pia Ericson).

The continuously changing nature of war in history has mostly been driven by changes in technology and our understanding of the changes it brings into war-fighting. Hence the terminologies in the military forces of the world also change, more often than war itself, mostly even introducing esoteric vocabulary. The term "air dominance" in this context is of comparatively recent origin. In some respects, people are correlating it to the terminology of the early decades of air power in the early 20th Century when overly optimistic assumptions about air power, the new weapon in the henceforth unconquered medium of the band of air above the earth's surface that had not ever before been fully exploited, led to the use of the term "command of the air" which would allow direct attacks on the enemy's centres of population and industry, forcing it to collapse, instead of having to defeat its armies (and/or naval forces) mile upon mile while marching up to the capital to change the regime. The concept of command of the air also assumed that air power could overwhelm the enemy completely and that there may even be no need for a ground war. To a large extent, this actually represented not so much the realities of air power at that time, but the hopes and perhaps even aspirational thinking of nations and their strategic thinkers who had watched the horrors of bloody massacre of then modern weapons like machine-guns, etc, during the land battles of World War I in Europe, where casualties were counted in each battle in tens of thousands per day.

However, by the time World War II broke out, the concept had been watered down somewhat to a more realistic "air superiority" and attacks on the enemy homeland and surface targets were brought under the label of strategic bombing offensive which was to subdue the enemy and its economic-industrial assets. All air warfare was not similar; different

Air Commodore JASJIT SINGH, Director CAPS on

'The Future of Air Power'

technology, tactics and training produced results which seemed to justify the concept of air superiority. It is worth recalling in this context that the German offensive in 1941 had led to the Soviet Air Force losing 40,000 aircraft in one week to the Luftwaffe! By the time World War II ended, the term command of the air had completely disappeared, being perceived as unachievable (due to the shrinking of air forces), unnecessary (in view of nuclear weapons achieving far more with much less to subdue the enemy) and unaffordable (due to the rising costs of air power systems).

The dawn of the nuclear age since Hiroshima and Nagasaki brought about another change in the doctrine of air power. Strategic bombing was now seen to be co-terminus with nuclear strike (initially with aircraft and later joined by ballistic missiles, both land-based and sea-based) and nations came to believe that in the nuclear age, there would not be enough time or capability to even fight the battles for air superiority, leave alone achieve it. Advances in technology and the concurrent higher costs of aircraft and their weapons had begun to reduce the size of air forces down from tens of thousands in the most powerful countries to a few thousands, though with far more capable aircraft. The inventory of a few hundred combat aircraft in the air forces of the middle powers, along with improvements in radar, etc., reduced the potential for aerial engagements. The demands on air forces for support of land forces, if anything, increased if for no other reason than technological advances which had also increased the firepower and mobility of ground forces, in a way making them more vulnerable to attack from the air.

The war in Korea took place during the twilight period when nuclear weapons had not begun to completely dominate strategic thinking across the world. For the US /UN Command, eliminating the North Korean Air Force was a necessary

starting point for its own air campaign, but in itself, was insufficient to ensure air supremacy. Ground-based air defence systems remained a constant danger and ultimately accounted for 816 of the 1,041 UN Command aircraft lost to enemy action. Of the remaining 225, as many as 147 were shot down in air-to-air combat and 78 lost to other enemy action. US fighters also made a seminal contribution to the war on the ground. The US Air Force (USAF) alone flew seven close support interdiction missions for every counter-air (including air-to-air) mission. But this ratio must be seen against the reality that the US / UN Command possessed air dominance rapidly after the North Korean Air Force has been completely destroyed very early in the war and the Chinese Air Force intervention, relying on bases inside China, had remained geographically limited to what came to be known as "MiG Alley" extending to a maximum of around 150 km from the Chinese border. By that time, the ground war had settled to the 33rd Parallel, the original ceasefire line between the two Koreas. In view of a negligible air threat, except for the MiG-15 farther north, this also allowed the US /UN Command to concentrate heavily on offensive air support and interdiction to the land forces even with daylight bomber attacks on targets in North Korea. According to Futrell, "The Chinese recognised that they had failed on the ground in January 1951 because they had failed in the air." But the same could be said for the US /UN Command at that stage.

The reality was that the ground war was stalemated and for the next two years, the two sides were left with no option but to engage each other in a classical battle for command of the air. And even here, the exchange ratio was almost even. The Chinese could not provide direct support to their ground forces because the battle front was beyond the radius of action of the MiG-15s, nor could they establish airfields in northern Korea because of the US/UN Command bombing and strike missions. And the US /UN Command could not cross the Yalu River owing to political-strategic constraints (especially after Gen MacArthur was removed from command), thus making the Korean War in reality a limited war since the primary players on either side, the US and USSR, were both nuclear-armed. The final outcome of the air war in Korea was then narrowed down to calculations of the exchange ratio where the US/ UN Command did not necessarily and unambiguously come out on top even after deploying the latest F-86s against the Russian/Chinese MiG-15.

The Battle of Britain has been seen as, written about, and honestly believed to be, the epitome of air superiority.

Since then, with nuclear weapons ready to be launched to even completely destroy the world, based on various factors for one reason or the other, the term air superiority appeared to be an idle luxury in spite of the fundamental realities having remained unchanged. The Western strategic thought and literature started to endorse that nations that did not possess nuclear weapons were not expected to prosecute what was believed to be a prolonged conflict if air superiority was to be achieved. Overall, the lack of time to wage a long struggle in the air, the air space having been made more transparent by radar, and lack of such capacity in war-torn nations, was believed to have made the battle for air superiority ephemeral. The concepts accordingly got altered and the best outcome in employment of air power in air warfare was seen as creating a "favourable air situation." This is what staff colleges started to teach and air forces started to believe in. Of course, it could never be clearly defined what this term "favourable" implied and in what time and space paradigm this could work. If it meant that the hostile air force would be forced on the defensive, thus providing favourable advantage to own air force, then it was no different from the concept of air superiority. In that case, the issue was merely one of scale rather than concept.

But semantics have a strong influence on actions and the substance of war. A combat campaign aim circumscribed by semantics instead of concepts would be very likely to limit the scope and the ways and means of the desired end, in turn affecting the achievement of the substantive aim which, in this case, would be dominance over the other air force, especially its offensive power.

Air superiority was not necessarily meant to be achieved as a full force-to-force or/and country-wide equation, though ideally it was meant to be aimed at as a campaign to achieve it in those terms. For example, the Battle of Britain has been seen as, written about and honestly believed to be, the epitome of air superiority. But it was limited to German bomber attacks on British airfields and later the aircraft factories as the focus of

Achtung, Spitfire! Classic painting of RAF Spitfire attacking Luftwaffe Heinkel He-111s.

Rafael

operations. In spite of the battle being fought by the Royal Air Force (RAF) with great courage and élan, the trend was clear: the sheer weight of persistent attacks by the Luftwaffe would finally push the RAF to a tipping point when the output of fighters from the factories would become less than the losses during the battle. The German Air Force was not defeated in the Battle of Britain but switched its attacks to British cities, allowing just that margin that the RAF needed to recuperate and rebuild its strength and go on the offensive. One could argue that the Battle of Britain was a battle for a favourable situation. But the fact is that if the RAF had lost the battle, with the Germans continuing their attacks on aircraft factories and fighter bases, the RAF would have been debilitated, unable to ward off Luftwaffe offensives and the resulting advantage would have rested with the Germans, making it possible for them to launch an invasion of the island state.

The essence of air superiority was that the hostile air force being pushed back on the defensive as far and deep as possible, and not necessarily destroyed, although that would come in the case of total success. Incidentally, the same principle is a prerequisite in the case of land forces on surface of the earth.

But being pushed back does not necessarily imply a simple falling back or failing to lose its fighting capability because the attacking force is likely to press home the attack and pursue the enemy to the final point of a "decisive victory." Air forces losing air superiority could hunker down in hardened shelters and try and recoup under the cover of air defence weaponry or, as the Iraq Air Force did in the 1991 Gulf War, simply fly off to another country to escape the persistent offensive for air dominance by the US -led coalition forces.

One effect was that the relative importance of air power missions after the end of World War II started to get diffused and altered. For example, if air superiority, leave alone command of the air, was going to be time consuming and/or unachievable, then air (to air) warfare, as distinct from nuclear delivery by aerial platforms, by itself assumed lower importance than other missions. Strike packages were reduced to as little as two aircraft missions even for deep strike and penetration of the hostile dense air defence environment. One effect was that close air support, always perceived to be an important mission, started to be seen as a far more critical mission than even air superiority. Most militaries in the developing countries simply adopted the dominant view that were protected by nuclear weapons and narrowed their vision on dependence on the concept of air superiority. In turn, view spread among land forces, especially in developing countries, that air power except when used with nuclear weapons, was primarily a supporting service and the land forces the supported force.

On the other hand, Commanders of the North Atlantic Treaty Organisation (NATO) land forces during the Cold War (facing large size air forces of the Soviet bloc) did assert that their first priority was to keep the enemy air off their backs, essentially implying a doctrine of air superiority even though it was not formally included as such! To a large extent, this has been due to historical experiences embedded in professional circles and elite perceptions that armies fight and win wars. The fact that armies have historically been perceived as the primary instrument of war and the military power of a nation, reinforced this perception. But the UK had accorded its Navy the status of "senior" "Service" because of its dependence on the Royal to keep any invader away from its shores through command of the seas, besides being the prime instrument to establish the vast empire that Britain set up and controlled till the mid-20th Century.

> The United States Air Force has consistently placed its trust in the concept of air superiority.

Air-to-Air Dominance

Thus it transpired that by the time the Cold War ended two decades ago, the dominant doctrines of most air forces were based on seeking and achieving a favourable air situation. As noted above, the purist, of course, would argue that completely favourable air situation in time and space would naturally amount to air superiority. Hence, the more modest doctrine was satisfactory expression of the prevalent realties and practices. But this ignored that the US Air Force had never given up its faith in air superiority and equipped and trained itself to achieve it in the shortest possible time. In fact, the wars of the past quarter century clearly point to the assignment of the almost total air effort of US–led forces to support of the war on the ground and at sea. But the important point is that this could be grossly misleading: in these wars

Not one sided: Messerschmitt Me-109 shoots down Spitfire.

Thales

air superiority was not contested since the hostile air force was either too inferior or too small to make the requisite impact against the sole surviving superpower employing air power in an offensive role, supported by high technology combat support air power and intelligence capabilities.

Here we must clarify that we are first addressing the issue of air-to-air dominance, that is more in tune with classical concepts of air superiority, although our study would include the new phenomenon, that of air-to-surface dominance, later on.

After World War II, the simple logic of air power was forgotten: that dominance of hostile air power would intrinsically allow for greater freedom of action to the friendly ground and naval forces, and deny the same to the enemy. As air power becomes more potent in lethality and long-range strike capabilities in future, the importance of balance in the air becomes more crucial. In a different way, this has been the lesson of all wars since end of the Cold War where air power enjoyed uncontested supremacy. This is the basic factor that allows air forces to provide a higher level of support to the land forces. And this is the critical factor why air dominance should be treated as the primary mission of air forces in the coming decades, except in extreme contingencies like an enemy breakthrough in our defences, as was the situation in Chhamb on 1 September 1965.

There is one other air force – that of Israel—which has consistently believed in the doctrine and strategy of air superiority.

There is, of course another air force - Pakistan's — which had claimed that it fought and won air superiority in the 1965 War and there are many in India and its air force, even at high levels, who have tended to believe it. John Fricker gave it a degree of perceptive legitimacy by adopting *Battle for Pakistan* as the title for his book on the 1965 War, psychologically linking it with the Battle of Britain. But the facts speak exactly the opposite, with the Pakistan Air Force losing three aircraft to one of the Indian Air Force in air combat in 1965, although the IAF till recently went by what our staff college taught: favourable air situation, often with the rider of its being "local." The Indian Air Force, which certainly won air superiority in both 1965 and 1971, has remained humble but ambivalent.

With the limited size of the combat force available in the western sector in 1965, the Indian Air Force strategy was mainly premised on air superiority in the war zone up to a depth of around 30 km, while providing interdiction and close air support to the Army. This resulted in forcing the Pakistan Air Force on the defensive since it started to lose fighters in a ratio of 3:1 compared to the Indian Air Force in air combat and went over to terminal defences of its airfields. Another example was that of the famous 'Tikka Offensive' planned by Pakistan in the 1971 War which was for both the Army Reserves to launch a coordinated attack through the Hussainiwala and Suleimanki headworks with the complete support of virtually the whole of the Pakistan Air Force, which expected to lose one-third of the force in the seven days required by the 'Tikka Offensive' to occupy a large chunk of Indian territory south of the Sutlej. Ultimately, the offensive never took off because two Mystere 'tank buster' squadrons had seriously dented the Pak Southern Army Reserves during the opening days without interference by the Pakistan Air Force.

USAF F-15 Eagle in air superiority configuration.

The USAF has consistently placed its trust in the concept of air superiority. For an air force that seeks to operate outside its own territory, it could not be otherwise since it puts the potential adversary on the defensive to start with. As Gen Michael Carns, the US AF Vice Chief Staff in 1992 had stated in his Congressional testimony "Our job is to stay one technology ahead of the potential adversary, and given that the former Soviet Union has now sold Su-27s and MiG-29s to 11 nations already and is looking for sales to others, we have situations developing when even in a regional contingency, the F-15 (USAF top of the line fighter at that time) might meet its match. That is not our policy.

Our policy is to have air supremacy and to make sure that the (US) Army is never attacked" (emphasis added).

But there is one other air force – that of Israel - which has consistently believed in the doctrine and strategy of air superiority and in this process, also proved that gaining and maintaining air superiority is not necessarily dependent on prolonged air battles — nor is size the deciding factor. In fact, the Israeli Air Force was clearly the smaller force compared to the Arab Air Forces arraigned against it in every war. The reason why Israel pursued this doctrine is because its very survival depends upon it and that is why it is perceived within the country as "Israel's Best Defence" and enjoys a special status. And hence, every time it had to fight a war, it won essentially because it won the battle for air superiority and every time, the tactics and strategy were different. That it did so also in a very short time every time only adds to the logic of the doctrine by proving that the dominant view in the world about air superiority - and what we taught in our staff college - was flawed. In fact, its dramatic success in the 1982 Beka'a Valley War was the precursor of the 1991 Gulf War a decade later, with the difference that the latter was on a much bigger scale and hence attracted greater attention in spite of the fact that over Beka'a Valley, the Israeli Air Force achieved proportionately higher effect with a much smaller force in much shorter time than the US-led Coalition achieved even in the 2003 Iraq War. But the Israeli Air Force had already demonstrated its doctrine of air superiority in the Six-Day War of 1967 and again in the 1973 Yom Kipper War once it had access to Electronic Counter-Measures (ECM) pods from the United States after the first day's fighting when it lost over 100 aircraft in close air support trying to stem the Egyptian surprise offensive across the Suez Canal.

On the other hand, there is one country that has gone back to the thinking of the early years of air power history. China had used its air force on an extensive scale in the Korean War in 1950-53 but the outcome was inconclusive. During its invasion of Tibet in 1950, in the 1962 Sino-Indian War and the 1969 Sino-Soviet War, it did not use its air force possibly because of its increasing obsolescence. During the 1979 Sino-Vietnam War, it hardly attempted to engage (leave alone challenge) the Vietnamese Air Force although its 6,000-strong air force possessed a much larger number of MiG-21 fighters than did its adversary. Curiously, it also did not really apply its air force for ground support either - a mission it appears to have shied away from in all the wars it has fought since the PRC (People's Republic of China) came into being.

China, which otherwise cannot be accused of transparency in its policies, spelt out its official policy in the White Paper on National Defence 2004, that it is planning for a local border but which will be won by "command of the air" (besides command of the sea and use of strategic

Russian Air Force MiG-29 shows off its array of air-to-air missiles.

forces). It may be noted that China is the only country in the world, after a gap of eight decades since the days of Douhet and Mitchell, to formally define "command of the air" as its stated strategy for winning future wars. This appears a far more aspirational than realistic doctrine in the modern world. But given China's rise to power, and the massive modernisation of its air force during the past two decades, one needs to take note of the nature of this pronouncement regarding its defence policy and its future implications. This announcement did not come as a complete surprise since Chinese political and military leaders had been stating in earlier years that China would shift from the classical doctrine of 'People's War' to a more modern and offensive concept. The air force leadership had been pointing to a clear shift toward a larger air offensive role for dominance in and from the air. For example, in 1999, the Commander of the Chinese Air Force had publicly sought a greater role for the People's Liberation Army (PLA) Air Force, declaring that the Chinese Air Force will strive for a transformation from the air defence type to an offensive and defensive type as soon as possible. He announced, "At the turn of the century and in the early part of the new century, the Air Force will have a batch of new types of early warning aircraft, electronic-equipped fighter planes and ground-to-air missiles" and that the air force "*must give more prominence to air offensive*, *gradually integrate offensive and defensive, and build up a crack, first rate air strike force"* (emphasis added).

It is against this historical background that we need to understand air dominance and its future. Most people who use this term actually refer to it in lieu of air superiority. But, in reality, this is only one of the aspects of air dominance. Air-to-air dominance of the adversary is certainly crucial for any future war, even among nuclear weapons states if they do go to war and may be the only way to apply coercive and punitive conventional military power in a nuclearised environment. Air-to-air warfare had moved out of the line-of-sight limitations long ago to become all-weather and day-night warfare. But air-to-ground warfare had remained limited to line of sight strikes and, hence, also fair weather essentially because of limitations of the available technology to locate moving targets on the ground. In recent years, the envelope of air-to-air warfare has vastly expanded in height as well as in distance due to the increasing ranges of air interception radars and longer range air-to-air guided missiles. Availability of Airborne Warning

The Chinese Jian-10 (J-10) is a multi-role, all-weather fighter aircraft designed for both air-to-air and air-to-ground missions.

The Chinese Air Force will strive for a transformation from the air defence type to an offensive and defensive type as soon as possible.

Israeli F-4 Phantom over the Negev desert.

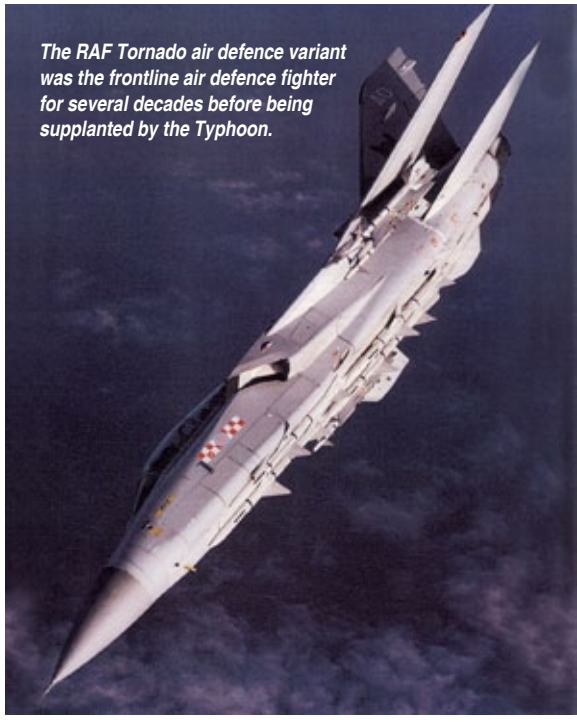
Air-to-Surface Dominance

But the real change that is taking place technologically, doctrinally and operationally, is in the increasing potential of air-to-surface dominance with long-range strikes with precision guided weapons. While few countries can possess capabilities of the US Joint Strategic Target Attack Radar System (J-STARS) type, it is clear that advances in sensor technologies and use of Unmanned Aerial Vehicles (UAVs), for example, create capabilities that are within the reach of even middle powers. Here it is useful to note that the ultimate importance of air power rests on its strategic role and capability, unmatched by the other two Services. This is owed to the very nature of the medium it operates in. Air power can influence and even control the movements and actions of surface forces. But ground forces and naval forces cannot interfere with the movements and actions of air power except in a limited sense through terminal defence. And if aircraft can launch weapons with the requisite accuracy from beyond the range of such terminal air defence weapons, air power becomes completely independent of even that limited imposition by surface forces. It may be recalled that air-launched, sea-skimming anti-ship missiles used in the 1982 Falklands War, launched from 15,000 ft altitude and as much as

and Control System (AWACS) and Airborne Early Warning and Control (AEW &C) capabilities has further contributed to this process, bringing these capabilities within the reach of even countries like Pakistan whose economies are disastrously fragile. Beyond Visual Range (BVR) air-to-air guided missile ranges have increased substantively, even claimed as beyond 100km. Hence, the battle for air-to-air dominance would certainly exist as a follow-on to the struggle for air superiority.

> The real change taking place technologically, doctrinally and operationally, is the increasing potential of air-to-surface dominance with long-range strikes with precision guided weapons.

This also raises the issue of what is the fundamental difference among the three components of military power. All three components of military power operate in three different mediums that have their own attributes, imposing limits and enabling capabilities as a consequence of this factor. This differential character of air power had led Lord Trenchard, the 'Father' of the Royal Air Force to state, *"A strategic force can be defined as a military force capable of assuming command of its own medium by its own resources. Until the advent of the airplane, the army and navy were valid expressions of the nation's ultimate military power on land and sea, respectively. With the development of aircraft, however, that ceases to hold true."*


The RAF Tornado air defence variant was the frontline air defence fighter for several decades before being supplanted by the Typhoon.

Indian Air Force Mirage 2000H, equipped with both short range and BVR missiles.

60 km away from the target ships, had imposed severe damage and limitations on the Royal Navy. Much worse would have been in store if the Argentineans had possessed few more Exocet anti-ship sea-skimming missiles and/or their aircraft had some additional range. This is the central factor that makes air forces intrinsically capable of achieving strategic effect.

The basic reason for air-to-surface dominance lies in the basic attributes of air power. Air (and space) power, exploiting the vertical dimension, is in a unique situation of being able to influence, and if properly configured and employed, to control the employment of land and sea forces below. The reverse is not possible, except in an extremely limited way by surface weapons employed for terminal defence for limited ranges. This unique attribute provides air forces with the quality of being a strategic force capable of achieving strategic effect. This is due to the combination of mobility, firepower, reach and flexibility that air power intrinsically possesses. The only serious challenge that air forces have to contend with in the air is that posed by the enemy air forces, which in principle could possess similar or better capabilities. And air dominance cannot be exploited to its intrinsic advantages unless the hostile air force is subdued or, ideally, eliminated from being a factor in war. It needs to be noted here that many of the lessons of recent wars could be misread since the wars took place in an environment of near total dominance by the US (and its allies) in the air and space regimes.

Logically, air dominance capabilities should be planned during peace-time. Existential air dominance capabilities provide a powerful conventional deterrence capability. They would then confer a definitive competitive advantage in case of deterrence failure, enhancing the credibility of deterrence. Higher credibility of deterrence itself implies reduction of the risks of deterrence failure. But at this point in our history, while we aim for building future capabilities, air dominance in our case would have to be contested, in all likelihood from a position of disadvantage (if we are unable to rapidly restore the air power balance vis-à-vis China). Given the ongoing military modernisation and the unambiguous priority that China and Pakistan (since 1999) are giving to rapidly build their air forces, the decline in the IAF force level would have to be arrested on the highest priority before we can seriously address the issue of optimising air force capabilities.

It is not clear how far such reality is recognised that *it is the Indian Army that is likely to face the brunt of the effects of adverse air power balance far more than the Indian Air Force* since the ability of the Army to fight the land battle would be severely constrained by hostile air forces, especially if they can muster sufficient air dominance capability. Those that may doubt this need to recall 1962, when for a variety of reasons (including Army HQ placing higher priority on air-transported supplies than offensive air support), combat air power was not used in spite of being available, which would have made a seminal difference to the war on the

Pakistan Air Force F-16 D Block 52 multi-role fighter.

Electtronica

ground. This is likely to be much more crucial in the Himalayan terrain which would severely restrict the Army's ground mobility since the friction is much higher than in the plains. This can be rectified to some extent by the use of helicopters and light fixed wing aircraft (like the handful of Otter and Caribou aircraft which were used for this purpose to great advantage in 1962). At the same time, it is clear that artillery firepower would be most crucial in mountain warfare. But the handicap also must be recognised that in the Himalayan terrain, there would be few open spaces for siting the guns and these could become lucrative targets for enemy air power. In turn, this enhances the premium of air dominance in the Himalayan environment. The abiding lesson of warfare is that advantages in mobility and firepower (individually and collectively) provide the key to war winning and any disadvantage in this respect could be disastrous. And vulnerability in mobility as well as firepower would severely undermine the force employment options of the ground forces which could only be compensated by air power.

We need to recall that air-to-surface warfare had remained "line of sight" operations. The pilot of a strike aircraft had to essentially locate the target, acquire it visually and aim his weapons while keeping the target in his sights.

This obviously resulted in strike aircraft having to launch their weapons from as close as around 800 to 1,200 metres range and almost inevitably fly over the target area after weapon launch. This had led to making air defence as intense and dense as possible and, hence, the impact of air power was conditioned by the equation between the attacking aircraft and the air defences around the target system. Most weapons had remained unguided for the

Indian Air Force Sukhoi Su-30MKI with R-27 BVR air-to-air missile.

IAF Su-30MKI launches R-73 close combat missile during 'Vayu Shakti 2010'.

MIG

simple reason that technology, especially sensor technology, had not advanced sufficiently for precision guided weapons to be launched to hit the target any other way. All this has been changing due to access of new sensor and guidance technologies and almost all weapons launched during the 2001 Afghanistan War and the 2003 Iraq War were launched from 15,000 ft altitude (or more, even up to 25,000 ft in the case of B-52s), well outside air defence weapons of the adversary and from long distances, which also meant that the strike aircraft would not need to fly over the target area.

This capability of making air-to-ground strikes from beyond visual range (BVR) and hence, almost all-weather long-range accurate, reducing the number of weapons required to neutralise a target as well as reduce the losses of the strike force, has tremendously enhanced the capability of air forces (that opt for the requisite technologies). This process, which had started during the Vietnam War, reached its highest point so far in Afghanistan and Iraq. This ability of air dominance of ground forces and targets with long range precision strikes is now increasingly available to air forces that absorb the lessons of history and refine their doctrines and strategy accordingly. However, the corollary is that the strike force must also have accurate and timely target information. In other words, readily available air intelligence is critical for the success of such air dominance. One can only agree with Richard Hallion when he says in his seminal historical study of air-to-ground air strikes: "Technology devoid of strategic thought and doctrinal underpinning is incapable of serving a nation's defence needs."

But these capabilities have not reduced tensions between land forces and air forces!. The US, which has extensive experience in joint operations, has again found that "The (US) Army and the Air Force experience the greatest inter-Service tension over the relative roles of ground and air power in war fighting. This tension largely results from how joint doctrine designates areas of operation (AOs) and how the Army views deep operations…"

This is not the only area of tension between the US Army and USAF. In spite of enormous investment in "jointness", the two Services have serious differences (Goldwater-Nichols Act notwithstanding), among other areas, with management and control of the air space in the battle zone. In recent times, this has erupted poignantly in Iraq where at least five collisions have recently taken place between UAVs and combat aircraft/ helicopters within a small area of 30-odd sq km above Baghdad, where close to 100 aircraft (including UAVs) are operating on a typical day. The disagreements are not about ownership, but actually about the "fundamental philosophies of command and control" of the two Services in spite of decades-old foundations of joint operations and unified joint command.

> Air (and space) power, exploiting the vertical dimension is in a unique situation of being able to influence, and if properly configured and employed, to control the employment of land and sea forces below.

This, in turn, raises the conceptual issues regarding coordination of boundaries between the air and ground forces. Land forces have tended to acquire weapons with increasing ranges and lethality and acquire a justifiable interest in what happens over the horizon and what has come to be known as the 'deep battle' in hostile territory, well beyond the ground battle contact line. But by their very nature, ground forces are far less effective as a force to conduct military operations well beyond the contact battle as compared to air forces. An objective analysis of the potential, and employment, of the 150km Prithvi and 300km Brahmos with conventional warheads to achieve discernible effect on war-fighting and war-winning would indicate their limited utility while complicating coordination challenges, while markedly raising nuclear ambiguities which could hardly serve our interests. Air assets provide the best and mostly the only capability to effectively undertake operations in depth and beyond the immediate battle, especially when this is limited to the local-border war framework. This is exactly what strategic reach of the Air Force makes possible to enable strategic effect to be achieved.

With regards to optimising single Service capabilities, war in the vertical dimension has to be fought and won by the Air Force by its own means and air dominance would remain its pre-eminent role and mission to provide the environment for war-winning. But air dominance, in both air-to-air as well air-to-surface superiority roles, would provide enormous freedom of action for ground and naval forces to conduct operations they are best suited for while undertaking (strategic and operational level) air strikes and support missions contributing to the war-fighting capabilities of surface forces.

The primary role of the Air Force in respect of joint war-fighting would be to shape the battlespace at the operational and strategic levels, besides providing close air support and performing other roles like Intelligence, Surveillance, Reconnaissance (ISR), airlift and others.

Ground forces now possess overwhelming tactical dominance capabilities and the optimum role for their employment in a local border war would be to force the enemy to react at the operational level by either concentrating forces or moving his reserves, thus making them vulnerable to air attack with air-to-surface dominance of the Air Force. Similar principles apply in respect of application of air power in the naval environment, possibly with greater effect since the protection provided by camouflage, dispersal and other survival strategies is not available at sea, making naval assets more vulnerable to air power. In the ultimate analysis "Air power is a strategic force in that it offers the opportunity to defeat the enemy's strategy — sometimes (sic) directly but most often in concert with other forces" Optimising air power capabilities and force application provides seminal asymmetric advantages in war winning strategies.

As noted earlier, the greatest inter-Service tension in modern militaries across the world has been found in the relative roles of ground and air power war-fighting. The crux of success of joint war-fighting is that both the land force Commander and the air force Commander must accept that the roles and effects created by each component lead to maximising war-fighting effects within the bounds of land and air power

Textron

True shape of air dominance today: pair of US Air Force F-22 Raptors.

capabilities. A recent seminal study by RAND came to the conclusion that a clearer division of responsibility between the roles and missions of ground and air power would go a long way in enhancing joint war-fighting. Thus it has concluded that the principal role of the land forces would be to employ its overwhelming tactical dominance to:

- "Force enemy reaction at the operational and strategic levels by forcing concentration and/or movement, thus making them vulnerable to air attack.
- "Close with, and finish, enemy tactical remnants, exploit success and seize and hold ground.
- "Deal with the post-conflict security environment until the desired strategic political end state is achieved."

The role of air power, according to this study, argues the author, should be to:

- "Shape the theatre at the operational and strategic levels.
- "Provide close air support (CAS), intelligence, surveillance, and reconnaissance (ISR) and lift to support ground combat operations.
- "Provide CAS, ISR and airlift for ground-force operations to secure and stabilise the theatre."

However, we must note a caveat here. The study and experience of the US military in war-fighting since the end of the Cold War (Gulf War 1991, Bosnia 1995, Kosovo 1999, Afghanistan 2001, Iraq 2003) have been against enemies that did not possess air power, except for Iraq in 1991, which was rapidly neutralised by the far superior US air power. The clear lesson is that the above recommendations assume total command of the air. In India's case, this is not likely to be and that command would have to be contested. Hence, the role of seeking and achieving 'air dominance' would be a prerequisite to the ground and air power roles outlined above. It is useful to recall that NATO land force Commanders in the early 1980s used to specify that their highest priority was for the air forces to "keep the enemy air forces off their backs."

Where would air-to-surface dominance provide the greatest payoffs? By any logic, this would come from neutralising the enemy's army reserves, preferably before they can begin moving and at least when they try to reinforce the battle. In a way, this was one of the major achievements of the Israeli Air Force during the Beka'a Valley operations in 1982 when, having neutralised the bulk of the Syrian Air Force, it set about systematically destroying the Syrian 3rd Armoured Division moving up to strengthen the ground battle. This logic was at the root of the US /NATO doctrine of "Follow-on-Force-Attack" (FOFA) in the early 1980s. The logical progression of the capabilities for air-to-surface dominance would lead to the major task of the ground forces to make the enemy move and then for the air force to destroy them. This is the way that air forces can best shape the future battlefield; by the same logic, the air forces would accord a high priority to protection of our own army reserves from potential attacks by the enemy air force.

> The primary role of the Air Force in respect of the joint war-fighting would be to shape the battlespace at the operational and strategic levels, besides providing close air support and performing other roles like ISR, airlift, etc.

Pilatus

Arming the M-MRCA : Deep strike missile options

Stand-off surface and sea strike systems have revolutionised air warfare in recent times, displaying precision accuracy and ensuring safety of the aircrew. With the Indian Air Force poised against potentially numerically superior opposition, stand-off weapons have emerged as the "game changers" for future air operations. The following article reviews various Western-origin stand-off weapons, including the Lockheed Martin AGM-158 JASSM, MBDA SCALP/ Storm Shadow, MBDA Taurus KEPD 350, Boeing Harpoon Block II, Raytheon AGM-88 HARM and Raytheon AGM-154 JSOW, all of them potential weapon systems on the IAF's M-MRCA choice (again, on Western-origin aircraft types).

MBDA SCALP/Storm Shadow being launched from a Tornado GR4.

The Lockheed Martin AGM-158 JASSM.

Lockheed Martin AGM-158 JASSM

Currently deployed by the United States Air Force (USAF) with its B-1 Lancer, B-2 Spirit and B-52 Stratofortress bombers and F-16 Fighting Falcon, the Joint Air-to-Surface Standoff Missile (JASSM) is a 14 foot long, 2,250 lb in weight, autonomous, stealthy, long-range standoff missile designed to destroy high value, well defended fixed or relocateable targets, from ranges of over 200-nautical miles. The missile is also employed by Australia and South Korea and should be the weapon of choice of the IAF if the F/A-18IN or F-16IN emerges as the M-MRCA selected. The autonomous navigation, based on inertial and Global Positioning System (GPS) systems, follows a pre-planned low-level terrain following route to the target area and once in predesignated location, the missile employs its Imaging Infra Red (IIR) seeker of medium wavelength sensor using a 256x256 Focal Plane Array (FPA) and on-board, real-time Automatic Target Correlating (ATC) algorithms to precisely locate and impact at the desired target point. The missile is also prepared to engage enemy jammers.

Lockheed Martin's ATC algorithms use an insensitive, redundant approach with real-time processors to provide a robust system that significantly reduces the missile's Circular Error Probability (CEP) point any time of the day or night. This allows the missile to hit a precise spot, such as a hardened bunker, cave entry or ventilation shaft, using a target model built earlier. To make the missile more immune to GPS deception and jamming, JASSM Block 1A missiles are equipped with Selective Availability/ Anti-Spoofing Module (SAASM) technology, which itself is an enhanced, digital anti-jam GPS receiver. This capability gives JASSM the ability to successfully complete its mission even in intense jamming environment. JASSM is equipped with a WDU-42/B (J-1000) 1,000-lb dual mode blast-fragmentation penetration warhead with 240-lb of AFX-757 for maximum effect against hard targets. One of the unique features of the current model of JASSM is its capability to send back a sequence of pre-strike images of the target, just before impact and in the process providing partial Battle Damage Assessment (BDA) capability.

Further improvements of JASSM ER will include a more powerful engine and larger fuel capacity, with improved two-way datalink which will provide flexible re-targeting of the missile, including against tracked or moving maritime targets. The ER version maintains the same outer mould lines of the stealthy airframe, which makes JASSM extremely difficult for air defence systems to engage. It also retains the dual-mode penetration and blast fragmentation warhead of the baseline JASSM missile. This capability will transform JASSM into a network-enabled system, providing in-flight re-routing, re-targeting, or aim-point refinements and blue-force tracking, to eliminate fratricide risks. Introduction of the JASSM-ER will also provide limited loitering capability or further range extension beyond 500-nautical miles. Loitering will enable planners to more flexibly integrate JASSM with other means of attacks, such as decoys and defence suppression weapons. Flight testing of the JASSM-ER began in mid-

2006 and initial fielding is expected with B-1B squadrons by 2013. The USAF plans a total procurement of 4,900 JASSMs, both the 200-nautical miles basic weapon and 500-nautical miles JASSM-ERs. By late 2009 the weapon had successfully completed six successful flight demonstration tests at the White Sands missile testing range in New Mexico. During one flight test, the missile was released from a B-1B aircraft and flew a pre planned course to collect data, to fine-tune navigation algorithms and then destroy the designated target. The flight also confirmed the missile's ability to be employed from the aft weapons bay of the B-1B. Flight testing will continue in preparation for Operational Test and Evaluation, which will commence in 2011. A low-rate initial production decision is anticipated in 2011. The JASSM-ER missile is being integrated on the B-1B with Initial Operational Capability planned for early 2013.

MBDA SCALP/Storm Shadow

The MBDA turbojet-powered 5.1 metre long, 1,300kg in weight and 250km+ range SCALP/Storm Shadow Conventional Attack Stand-Off Missile (CASOM) qualifies as a mini-cruise missile, capable of successful counterforce operations against enemy high value conventional and nuclear infrastructure by conventional strikes alone, yet stays clear from anticipated heavy enemy ground-based air defences. Designed to cruise at low-levels to avoid radar detection, it has inertial guidance and TERrain PROfile Matching (TERPROM) navigation with an integrated GPS during the terminal target approach phase of flight. During terminal phase in combination with passive Imaging Infra Red (IIR) sensors with Autonomous Target Recognition (ATR) system, the missile retains considerable autonomous capability over long ranges, while its effective Bomb Royal Ordnance Augmented Charge (BROACH) unitary penetration warhead is programmed to inflict maximum damage on impact, even on buried and hardened targets.

Recent enhancement programmes of the SCALP EG include the capability to relay target information just before impact, utilisation of link-back data-link to relay battle damage assessment with an option for in-flight retargeting capability, utilising a two-way data-link. The Storm Shadow was first successfully deployed with Tornado GR4 combat aircraft of the Royal Air Force's No.617 'Dambusters' Squadron during *Operation Telic* in 2003. A total of 27 missiles were fired during the conflict well proving the missile's exceptional capability to accurately engage targets at extended ranges whilst avoiding collateral damage and ensuring that the launch aircraft remained safely away from the target area. The missile forms standard CASOM of Dassault's Rafale fighter, also in the M-MRCA competition.

MBDA Taurus KEPD 350

The Taurus programme commenced in 1998 by pooling industrial capabilities in the field of precision stand-off guided missile systems of *LFK-Lenkflugkörpersysteme* GmbH (now MBDA Deutschland) near Munich, with those of Bofors in Karlskoga, Sweden. This led to the setting up of a joint venture company, Taurus Systems GmbH, based in Schrobenhausen, Germany, responsible for the development, production, marketing and logistical support of the Taurus stand-off weapon system. The Taurus KEPD 350 (Kinetic Energy Penetration Destroyer) weapon system is a modular cruise missile type weapon initially developed for German Air Force Tornado IDS strike fighters, yet can be adapted for the F/A-18, the Saab Gripen and Eurofighter Typhoon. Taurus KEPD 350 has had an extremely short development time, which began in 1998 and completed final testing in March 2004. Taurus KEPD 350 officially entered the German Air Force service with the JG33 (Strike Wing) on 21 December 2005.

Five metres long, 1,400kg in weight, the KEPD-350 has a range beyond 100km and is equipped with the *Mephisto* tandem penetration warhead which can effectively engage stationary fortified targets such as

underground bunkers and shelters whilst avoiding collateral damage. *Mephisto* is based on a large tandem warhead concept comprising a precursor/shaped charge and a high explosive filled kinetic energy penetrator. To trigger the penetrator charge so as to achieve optimum damage, Taurus uses the world's first smart active decision-making hard target fuse, the Programmable Intelligent Multi Purpose Fuse (PIMPF). Its shock sensor and intelligent signal-processing algorithm determines impacts and exits of hard layers and thus detects and records layers and voids. Reliable autonomous navigation is provided by fusion of sensor data from three sensors and includes Image Based Navigation (IBN), Terrain Reference Navigation (TRN) and MIL-GPS subsystems, as the use of such fusion enables the Taurus KEPD 350 to navigate over long distances without GPS support. The mission planning system supports planning and preparation of terrain-hugging flight paths at high subsonic speeds and terminal targeting in order to penetrate enemy air defences, programmed into the weapon by the ground loader Unit. As with the MBDA SCALP/ Storm Shadow, during terminal phase in combination with passive high resolution Imaging Infra Red (IIR) sensors with Autonomous Target Recognition (ATR) system having highly sophisticated line extraction algorithms, the missile retains considerable autonomous operations capability over long ranges. As a future enhancement, use of a data link is being examined for a correctly performed mission and partial BDA.

MBDA Taurus KEPD 350 with the Eurofighter.

Boeing Harpoon Block II .

Boeing Harpoon Block II

In early 2009 the United States Defence Security Co-operation Agency (DSCA) had notified United States Congress of a Foreign Military Sale (FMS) to India of Harpoon Block II missiles as well as associated equipment and services totalling $170 million. "The missiles will assist the Indian Air Force to develop and enhance standardisation and operational ability with the United States." The notification further stated "This proposed sale will contribute to the foreign policy and national security of the United States by helping improve the security of an important partner and strengthen the US-India strategic relationship which continues to be an important force for political stability, peace and economic progress in South Asia". The notification also assured "India will have no difficulty absorbing the missiles into its armed forces" perhaps indicating considerable technical and infrastructure assistance?

From the IAF's and Indian Navy's standpoint, possession of land attack missiles have emerged as a priority in view of emerging littoral warfare scenarios, especially in South Asia. Moreover as demonstrated during the summer of 1999, at least one potential adversary would perhaps be unwilling to deploy its surface naval fleet at the outbreak of hostilities and so needs to be engaged within their ports, harbours and naval bases. No wonder then, reports had emerged that the Government of India has requested procurement of twenty "littoral warfare specific" AGM-84L Harpoon Block II missiles, four ATM-84L Harpoon Block II exercise missiles along with containers, training devices, spares and repair parts, technical support and support equipment, personnel training and training equipment. The requirement also included technical data and publications, United States Government and contractor engineering and logistics support services and other related elements of logistic support. Only in late 2010 was it confirmed that the Harpoons were being procured to arm IAF Jaguar IM maritime strike variants for anti-ship strike.

The Harpoon Block II is an upgrade programme to improve baseline capabilities of the AGM-84D Harpoon anti-ship missile which was first introduced in 1977 to attack targets in congested

littoral environments since progressive development to land-attack variants continued in response to demands for an effective weapon in emerging littoral warfare scenarios. The Harpoon provides accurate long-range guidance for coastal, littoral and blue water ship targets by incorporating the low cost integrated Global Positioning System/Inertial Navigation System (GPS/INS) from the Joint Direct Attack Munitions (JDAM) programme. GPS antennae and software from Boeing's Harpoon AGM-84E Block 1E Stand-off Land Attack Missile (SLAM) and AGM-84E Block 1F SLAM Expanded Response (SLAM-ER) are integrated into the guidance section. The existing 500-pound blast Destex explosive warhead delivers lethal firepower against coastal and port targets.

For the anti-ship mission, the GPS/INS provides improved missile guidance to the target area followed by accurate navigation solution to allow target ship discrimination from a nearby land base using shoreline data provided by the launch platform. These Block II improvements will maintain Harpoon's high hit probability while offering a ninety-percent improvement in the separation distance between the hostile threat and local shorelines, thus reducing collateral damage. Harpoon Block II will be capable of deployment from all platforms which currently have the Harpoon Missile system by using existing command and launch equipment. A growth path is envisioned for integration with the Vertical Launch System and modern integrated weapon control systems. More Harpoon Block II missiles are in any event likely to be inducted by the IAF if the F/A-18IN or F-16IN emerges as the M-MRCA type selected, but the missile will also enter IN service with the Boeing P-8I Poseidon Long-Range Maritime Patrol/ Anti-Submarine Warfare (LRMP/ASW) platforms on order.

Raytheon AGM-88 HARM

The AGM-88 High-Speed Anti-radiation Missile (HARM) is a joint USN and USAF programme developed by the USN and Raytheon. HARM was designed as a technically advanced follow-on to standard ARM and Shrike missiles, with deliveries beginning in 1982. Continued hardware and software upgrades have allowed HARM to counter advanced radar threats. HARM has proven itself in both reliability and combat performance, its first combat use being in Libya in 1986. During *Operation Iraqi Freedom* in 2003, the launch of more than 400 missiles virtually eliminated any radar threat.

The 4.17 metre length, 363kg in weight, HARM's primary mission is to suppress or destroy surface-to-air missile (SAM) radar, early warning radar and radar-directed anti-aircraft artillery (AAA) systems. Once airborne, HARM can operate in three modes: pre-emptive, missile-as-sensor and self-protect. In long-range preemptive scenarios, HARM is fired before locking on to the threat radar. Targeting is provided through preflight planning or cued via onboard or offboard sensors. The Lock On After Launch (LOAL) mode is used for standoff maximum range attacks on emitters of a known type and location, within several degrees of the missile boresight. This is the basic mode used by Suppression of Enemy Air Defence (SEAD) aircraft such as the F-4G and Tornado ECR, or F-16CJ/HTS. The aircraft's Emitter Locating System (ELS) determines the identity and position of the target, which are downloaded to the missile. The missile is then 'tossed' to impart the best possible range. The missile flies on inertial guidance until it acquires the target, then homes to impact. The pre-emptive mode is essentially offensive and most commonly used when

taking down an Integrated Air Defence System (IADS). A sub-mode of the pre-emptive mode is Equations-Of-Motion (EOM) mode which allows more precise selection of emitters at maximum range, in a high density environment. The EOM mode is more specific than pre-emptive mode in terms of target selection and can engage off axis if required, but requires more precise target position information than the baseline pre-emptive mode. The target position data can be provided by an onboard receiver or data-linked from an external source.

Most aircraft are equipped to utilise HARM as a sensor, providing cockpit displays that enhance aircrew target selection and threat prosecution. The Target Of Opportunity (TOO) mode, also termed as Sensor (HAS) or Direct Attack (DA) mode is a lock-on-before-launch (LOBL) mode in which the missile receiver is used before launch to acquire the target. This mode allows off axis attacks on emitters within the field of view of the seeker. It is typically used as an offensive mode by non-dedicated strike aircraft to suppress emitters.

Radar Warning Receivers (RWR) used with the self-protect mode and other more sophisticated Electronic Support Measures (ESM) systems provide additional capabilities for locating enemy radar emitters. The Self Protect or Launch Off RWR (SP/LOR) mode is a short to medium range mode used defensively to engage targets within 360 degrees of the launch aircraft. In SP mode the HARM is slaved to the aircraft's RWR and given a prioritised list of threats. Once the aircrew selects the target, the missile is launched, homes in on the target, makes in-flight corrections and eliminates the threat. The highest priority threat will be engaged after launch. The SP/LOR mode is similar to the TOO/HAS/DA mode, but provides a larger search footprint.

HARM is produced by Raytheon and delivered to the United States military for use on a variety of USN, USAF and United States Marine Corps (USMC) aircraft, including the EA-6B, F-16 and F/A-18. The United States government makes HARM available to international customers through Foreign Military Sales (FMS) and a number of countries have selected HARM for use on F/A-18, F-16 and Tornado aircraft. There are a number of other aircraft that are candidates for HARM integration. Raytheon manufactures integration, test and support equipment that complete the HARM weapon system suite plus the depot for refurbishment and repair. HARM was designed with performance and quality in mind. In field use HARM demonstrates reliability four times better than specification, with performance accuracy reported as 30 percent better than design requirements. The real proof of a weapons system lies in its combat effectiveness. In all recent conflicts, HARM played a central role in suppressing and eliminating enemy radar threats and these missiles are likely to be inducted in IAF service if the F/A-18IN or F-16IN emerges as the M-MRCA winner.

Raytheon AGM-88 HARM on the F-16.

Raytheon AGM-154 JSOW

The AGM-154 Joint Standoff Weapon (JSOW) is a new generation glide weapon ensuring warfighter survivability by enabling precision air strike launches from well-beyond enemy air defences, at kinematic standoff ranges up to 130km. JSOW Block II development significantly reduced JSOW unit costs and added Selective Availability/Anti-Spoofing Module (SAASM) Global Positioning System (GPS) capability, which was completed in 2006. The family of JSOW precision strike weapons is modular in design with variants that can integrate different lethal submunitions, with a blast/fragmentation unitary warhead and

The Raytheon AGM-154 JSOW.

a hardened target penetrator that can be programmed for blast and fragmentation effects. JSOW targets vary from all types of area targets to hard point targets. JSOW's low RCS and IR signature are key stealth features and ensure a high probability of survival enroute to heavily defended targets. The blast/fragmentation unitary variant incorporates the insensitive 500lb BLU-111 (Mk.82). The BROACH penetrator/blast/fragmentation variant incorporates an uncooled Imaging Infra Red (IIR) autonomous terminal seeker and tracker and integrates the BROACH dual-stage blast/fragmentation and/or penetrator warhead. This variant enables precision attack of point targets. Since 1999, JSOW has been combat proven in operations *Southern Watch, NATO Allied Force, Enduring Freedom* and *Iraqi Freedom* with more than 400 weapons employed. More than 3,400 JSOWs have been produced.

At 4.1 metre length and weighing 475kg, JSOW variants can engage and destroy virtually the entire target set for U.S. forces, spanning a range of threat environments. All JSOW variants are guided to the target area by a highly-integrated GPS and Inertial Measurement System. JSOW receives the targeting information in preplanned mode, in the cockpit with data received while airborne through onboard sensors, or through other third-party targeting assets. After the AGM-154C BROACH variant arrives in the target area, it utilises the IIR seeker for autonomous guidance in terminal phase of the flight to attack with precision accuracy. AGM-154 is designed to take advantage of new developments in payloads and sensors through design modularity of the air vehicle. The payload bay can accommodate lethal and non-lethal payloads ranging from warheads to pamphlets to sensor packages. The terminal seeker space can accept the latest sensors as they are developed.

JSOW demonstrated all standoff accuracy and lethality requirements in a highly-successful development and operational test programme which demonstrated the ability to launch from high or low altitudes and accurately navigate to the target area via selected waypoints, further enhancing weapon and aircrew survivability. The JSOW A-1 (BLU-111) is currently in production for FMS only, and JSOW C is currently in production for four international FMS customers. The AGM-154C (BROACH) has demonstrated precision accuracy within approximately four feet in developmental and operational tests. The weapon is in full-rate production and achieved initial operating capability in February 2005. JSOW C-1 adds a two-way datalink and moving maritime target capability, is in full-scale development and scheduled for initial operation capability in Fiscal Year 2010. JSOW is integrated on the F-15E, F-16, F/A-18, B-2 and B-52 aircraft. JSOW is also a threshold internal bay weapon for the F-35 Lightning II. The aircraft compatibility built into the JSOW design will minimise integration costs for future aircraft platforms while the maturity and proven capabilities within the JSOW make this a user-friendly, highly-reliable, cost-effective system. Again, AGM-154 JSOW missiles are likely to be inducted in IAF service if the F/A-18IN or F-16IN emerges as the M-MRCA of choice.

Sayan Majumdar

MBDA

Air-launched, long range missiles with the IAF

Crystal Maze missiles from Israel

According to Shishir Gupta reporting from Jerusalem, the Indian Air Force has acquired the 100 km range air to surface stand-off Crystal Maze missile from Israel. Manufactured by Rafael, the Crystal Maze is similar to the Popeye all-weather bunker busting missile that is launched from an aircraft to destroy command and control centres, enemy bunkers and even militant training camps from a distance of 80-100 kilometres. The TV-guided missile, which has a 80 kg warhead, is highly accurate with an error range within three metres.

The acquisition of Crystal Maze missile is extremely significant for Indian offensive capabilities as for the first time, the IAF has an air-to-surface launched cruise missile that can be fired from an aircraft. The present Indo-Russian venture Brahmos is essentially an anti-ship cruise missile and this bulky missile has not yet been mounted on an aircraft. Essentially, the Crystal Maze is launched from a multi-role aircraft like the Mirage 2000 that climbs to over 40,000 feet and uses Lightning pods to fix the target from a distance of over 80 km. The missile is launched after target identification.

The Kh-31 'Krypton' from Russia

In service with the Indian Air Force and deployed with selected units operating the Su-30MKI is the Russian Kh-31 (Russian: X-31; NATO AS-17 'Krypton') air-to-surface missile. A sea skimming cruise missile with a range of 110 kilometres (60 nmi; 70 mi) or more and capable of Mach 3.5, this is the first supersonic anti-ship missile launched by tactical aircraft, and there are several variants.

The Kh-31 is conventionally shaped, with cruciform wings and control surfaces made from titanium, with a two-stage propulsion. On launch, a solid-fuel booster in the tail accelerates the missile to Mach 1.8 and the motor is discarded. Then four air intakes open up and the empty rocket case becomes the combustion chamber of a kerosene-fuelled ramjet, which takes it beyond Mach 4.

The Kh-31P ARM entered service in Russia in 1988 and the Kh-31A anti-shipping version in 1989. A few Kh-31P/KR-1s were delivered to China in 1997 but these were apparently for testing and development work. The Chinese ordered Russian missiles in late 2002 or early 2003, leading to 200 KR-1s in their inventory by 2005 to equip Su-30MKK's of the 3rd Air Division. In 2001 the IAF procured Kh-31s for Su-30MKI, reportedly 60 Kh-31As and 90 Kh-90Ps.

The UAV in Indian Skies

The word *Drone* brings to mind the classic male bee, "who does no work, is unable to fight and in no way contributes to the well being of the bee hive community except with the sole purpose of mating with the queen bee." By a quirk of fate, 'drone' is also the generic name for the Unmanned Aerial Vehicle (UAV) which is today poised to be the tireless workhorse of future airpower. Designed to fly in any part of the world and be the weapon of choice in asymmetric warfare, this has the potential to pose a challenge to the manned aircraft of the future.

From its humble beginning as drones or unmanned airborne vehicles they have evolved into a potent element of airpower. The Predator, Reaper, Heron and Searcher class of UAVs have proved their capability in combat missions albeit in an environment devoid of enemy aerial opposition. The use of UAVs has grown exponentially in the recent past. During the 2003 invasion of Iraq by the US-led coalition forces, UAVs flew about 35,000 hours and this had increased to 800,000 hours in 2008 over Iraq and Afghanistan.

The pace of change is phenomenal and there are over 250 varieties of UAVs in over 50 countries as diverse as Iran, Colombia, Belarus and Sri Lanka. Global sales of UAVs is expected to be around US$ 5 billion annually increasing to over US$ 20 billion by the year 2020, the major portion of this from the USA. Israel is next to the United States in development and possession of drones followed by the UK, France, Germany and Italy. Though China is reported to be trailing these countries, there is a view that this is an underestimation fuelled by China to maintain a secretive posture.

India also features prominently in the list of countries that will be a major operator of UAVs but the arsenal is limited by an inability to obtain UAVs with strike capability from Western sources. India has therefore heavily invested in Israeli UAVs like the Searcher II and Heron and there are DRDO's attempts to fill the gaps. The Israeli's have also supplied Harpy Killer drones which detect and destroy enemy radar installations. Following the Nishant and Lakshya programmes, the DRDO is developing the Rustom R.1800 Medium Altitude Long Endurance (MALE) for the armed forces, while the security forces are evaluating the T Hawk for augmenting their quick reaction surveillance and search capability. The Indian Navy too possesses the Heron and Searcher II which enables it to extend maritime reconnaissance capability (see *News*).The performance of the Heron during the 2004 tsunami proved its capability and potential.

Worldwide, military aviation is beset today with the problems of ever reducing budgets versus increasing costs, mandated personnel cuts, diminishing strategic targets for conventional warfare to name the obvious and importantly, adverse public reaction to battle casualties. At the same time, the need to maintain a credible Air Force to counter aerial threats cannot be wished away. The ever increasing costs of fighter aircraft make armed UAVs an attractive proposition. J Neal Blue, the CEO of General Atomics Aeronautical Systems Inc announced at the recent Farnborough Air Show that the Avenger version of the Predator, designed for high-speed long-endurance missions with Intelligence, Strike and Reconnaissance (ISR) capability, and carrying a 2000 pound weapon payload has undergone extended flight tests which have met design parameters. The Avenger

is bigger than most fighter aircraft, being 44 feet long with a 66 feet wingspan. It is reported that it has the ability to cruise at 400 KTAS, remain airborne for 20 hours and reach 50,000 feet. This brings about a new dimension in tactical planning of strike missions. General Atomics claims that for the cost of one manned fighter aircraft, "multiple swarms" of Avengers can blanket an area of interest, providing unprecedented 24x7 ISR coverage, target identification and neutralisation, mission flexibility and most importantly, attrition tolerance. Whilst these claims would need to be validated under near real time scenarios, the concept is very attractive indeed.

The potential of UAVs to either replace or augment manned fighter aircraft for combat missions is now emerging as one of the intriguing challenges of military aviation. On 12 July 2010, BAE Systems unveiled prototype of the Taranis Unmanned Combat Aerial Vehicle (UCAV) in partnership with the UK Min of Def, Rolls Royce and GE Aviation. The Taranis is reportedly as large as the BAE Hawk aircraft. This is a part of UK's Strategic Unmanned Air Vehicle (Experimental) programme which will work towards establishing the operational capability of UAVs explore and demonstrate how emerging technologies can provide a battle winning capability to UK Armed Forces. It is hoped that the Taranis trials will also provide the Royal Air Force empirical evidence on the potential of UAVs and will help in making decisions on the use of a mix of manned and unmanned aircraft in future force structure. With the UK Defence budget pared to the bone and reduction of strike aircraft creating a capability shortfall, the UAV is seen as a potential cost effective solution to bridge the gap.

The UCAV and UAV may appear to be a panacea for some Air Forces driven by budgetary constraints and changed strategic compulsions of the last decade. The tense security environment in some parts of the world, including the Middle East, India-Pakistan, India-China, China-Russia, China-Taiwan, North-South Korea and to a lesser extent in Iraq and Afghanistan, have not altered and air power is still a vital element of power projection in these countries. Air Forces operating in these theatres are examining the roles and tasks that can be off loaded to UAVs. There is a recurrent need to strike static and mobile targets deep inside enemy territory and an evaluation has to be made to establish if UAVs can bring this capability to the table.

UAVs of the United States, NATO and Israel have generally operated in a benign enemy air defence environment and opposing forces have been incapable of threatening the UAVs either in the air or by ground based weapons. The Indian Air Force has to empirically establish and conduct operational analysis that UAVs and UCAVs can augment its Intelligence, Strike and Recce capability in the hostile air defence environment along the Western borders and in the hilly terrain of the Eastern frontier areas. If the analysis gives positive results then the IAF soon has to arrive at investment decisions on the future mix of manned and unmanned aerial vehicles in its inventory.

The operational record of the Predator series puts in perspective the value of UAVs in combat. The Predator fleet has completed one million flight hours in just under 80,000 combat missions with over 85% of the missions flown in combat conditions. It was reported that the US is currently maintaining 41 Combat Air Patrols, 11 in Iraq and 30 in Afghanistan with patrol period of 22-24 hours. The cost of operating the Predator fleet is barely 10% of the cost of maintaining a similar fleet of F-16 aircraft, but the most important issue is that there is no loss of US or allied lives in UAV air operations and collateral damage on the ground is reduced.

A recent study by the Washington-based Centre for International and Strategic Study has stated that the U.S. military is actually conducting four different air wars over Pakistan:

- It is using unmanned drones to support U.S. forces in "hot pursuit" in the border areas.
- It is using drones to attack Taliban and other insurgent forces near the Af-Pak border to limit their capability to operate in Afghanistan.
- It is striking with drones at insurgent and terrorist leaders and training camps inside the tribal areas in Waziristan.
- It sometimes supports Pakistani forces in strikes against the Pakistani Taliban.

The Pakistan military is actively involved in planning and execution of many of these missions and is definitely building up its expertise on the use of UAVs in the tactical combat area. The latest United States $ 2.2 billion military aid to Pakistan is meant to provide weapons to fight counter terrorism and will in all probability include a range of UAVs which can certainly be employed against India if the need arises.

The proliferation of UAVs in the combat zone by the Army and Air Force brings to the fore some serious command and control issues with regard to the use of air power in the tactical battle area. Communications between ground control stations and the UAV and also between UAVs and fixed wing assets is another area where clear guidelines have to be established. Spectrum allocation for command and data communication with UAVs will need examination. The large scale acquisition of UAVs will have to establish new operational guidelines of command and control and interoperability of manned and unmanned aircraft in the same tactical environment. The Indian Army and Indian Navy are also acquiring UAVs to enhance their operational capability and the Indian Air Force has to initiate steps to keep abreast of these changes and refine the procedures for joint air operations with the Indian Army and Indian Navy.

In view of India's strategic compulsions, fighter aircraft will retain their pre-eminent position in defending Indian airspace and in the foreseeable future they will not be replaced by UAVs. However Unmanned Aerial Vehicles and Unmanned Combat Aerial Vehicles have the potential to augment manned aircraft in combat and be an important part of force structure of the three Services. The Indian Air Force should take the lead in managing the challenges of integrating the roles and tasks of manned aircraft and UAVs / UCAVs of the Army, Navy and Air Force in the airspace over India.

Air Cmde (Retd) KB Menon

IAI Malat

INAS 343 UAV Squadron commissioned

Maritime reconnaissance along India's western coast will be enhanced with the commissioning of an Unmanned Aerial Vehicle (UAV) Squadron at the Naval Air Enclave, Porbander. Designated INAS 343, this is the first Operational UAV Squadron under the Western Naval Command to enhance the maritime surveillance and coastal security in this region. The location at Porbandar is ideal for covering the Sea Lanes of Communication (SLOC) coming from the Gulf as well as providing surveillance cover to high value assets on Western Coast.

Dedicating the new UAV Squadron INAS 343, 'Frontier Formidables', the Gujarat Governor stated "that the induction of these assets into Gujarat will help secure our maritime boundaries as well as our shipping lanes and territorial waters besides making the 1600 kms coastline of Gujarat (longest among coastal states) with a large number of high value and critical national assets, more secure and tranquil".

In 2002, the Indian Navy inducted the first Maritime versions of Searcher Mk.II and Heron from Israel and in 2003, post training of operator crew in Israel, an intensive Flying Trial Unit (IFTU) was established at Kochi. After three years of extensive flying and trials, the first UAV Squadron in the Indian Navy was commissioned on 6 January 2006 as INAS 342, also Squadron having a dual task of undertaking operational missions besides providing training.

The UAV Heron.

The UAV Searcher.

The Searcher is a third generation UAV, capable of carrying modern and sophisticated Electro Optic Camera and Electronic Support Measure (ESM) or Communication Intelligence (COMINT) payload while the Heron is the bigger version of Searcher Mk. II which can carry heavy payloads including a Maritime Patrol Radar (MPR).

The Elbit Systems' Rattler

The emergence of micro-payloads for micro and mini-UAS has created a large market demand for very small laser designators with targeting capabilities equal to those of much larger systems. To meet this need, Elop has developed the Rattler A, a miniature, coded laser developed especially for the requirements of the modern battle field for SWAP : Size, Weight and Power. Rattler provides all of the parameters that a military designator system needs, such as full performance in harsh environments and designation for all laser guided munitions. It also enables observation payloads with full targeting capabilities, facilitating designation and coded illumination. Designed to be easily fitted into the smallest available payload (~ 5" diameter), the Rattler A is extremely compact and lightweight, with an exceptionally small form factor. Its cutting edge diode-pumped technology and a-thermal design provide a unique, cost-effective-solution. It can be easily offered in single or multiple LRU configurations.

The equipment will be very useful for current and future Indian UAV programmes which are under development. This can have many other uses and can be installed and integrated on a variety of equipment currently being used by the Indian Armed Forces.

Avi Oil

Low Altitude Digital Lakshya-2 successfully flight tested

On 20 December the Aeronautical Development Establishment (ADE), Bangalore, successfully conducted flight test of the Lakshya-2 Pilotless Target Aircraft.

The Indian Army/Air Force have indicated their requirement of operating the pilotless target aircraft at very low altitudes (15 to 25 metres above sea level) for simulating trajectory of low-level cruise missiles. Accordingly ADE has re-confirmed that Lakshya-2 with necessary hardware and software for meeting the user requirements. The 32 minutes flight test was controlled by a ground control station and the low altitude flight was over a 10km flight. "The flight was stable and well controlled".

The PTA also demonstrated its manoeuvring capability, simulating low level attack aircraft. The system has been designed so that two Lakshya PTAs can be simultaneously flown and controlled by a Common Ground Control Station.

DRDO Aerostat System

The DRDO has demonstrated an indigenously designed and developed aerostat system capable of carrying electro-optic and COMINT payloads for surveillance, trials of the system concluding on 25 December 2010, which included surveillance over Agra and interception of variety of communications. ELINT and radar payloads are also being developed indigenously. This platform is

Medium size Aerostat on mooring.

a result of development of a number of high end technologies in the field of aerodynamic design of balloon, fabrics, fabrication, hydraulic winch, electro optic tether, high pressure helium cylinder manifold, active pressure control system etc in association with large and medium sized Industrial partners.

The system has been designed, developed and integrated by the Aerial Delivery Research & Development Establishment

EO and COMINT payloads mounted on Aerostat.

(ADRDE), Agra Cantt, under the Defence Research & Development Organisation (DRDO) working in the field of parachutes, lighter than air systems, floatation systems and aircraft arrester barriers. Over the last few years, ADRDE has diversified in the field of lighter than air (LTA) technologies and developed small and medium size Aerostats, a medium size helium filled Aerostat and successfully test flown up to one kilometre altitude at Agra.

Dr Prahalada, DS & CCR&D (Aerospace & Services Interaction) recalled out the fact that ADRDE had graduated from a laboratory designing and developing balloons, parachutes and heavy air-drop systems to developing systems of systems.

Elbit

Taranis

Wings of the Next Century

Richard Gardner reports from the UK on the Taranis, a stealthy new unmanned air system from BAE Systems

There can be little doubt that the pace of air warfare is about to change, and that change is probably going to be as radical as the move from piston-engined combat types to jets in the late 1940s. After six decades of the supersonic jet age dominating operational planning, the sheer cost of sustaining a like-for-like replacement policy is becoming cripplingly expensive. The decision of the US government to cut back on the number of F-22 air dominance fighters it is buying (186) is way below the original procurement estimates but this reflects not only a new economic reality but also the fact that there are now better ways of doing things, to achieve more with less. Although the US is to store the jigs and tools to retain the option of building more F-22s in the future, the anticipated unit cost of $227 million each makes such a production re-start highly unlikely. Today's multi-role combat aircraft offer a powerful mix of capabilities but the supersonic manned fighter has reached a development plateau and the time is approaching when new options will start to achieve operational status paving the way towards a very different new century of air power. The Taranis could be part of that revolution.

The official unveiling of Taranis at BAE's secretive Warton advanced projects site came only four years after the programme was launched in 2006. This is a remarkably short development period for such an ambitious project and was made possible only because it was managed within a very tight industrial partnership arrangement between BAE Systems, the UK Ministry of Defence, Rolls-Royce, QinetiQ and GE Systems and on a purely national UK scale. Taranis leverages experience from several key advanced technologies gained through a decade of unmanned company demonstrators, including the Corax, Raven, Herti and Mantis. These de-risked and proved, through exhaustive ground and air tests, the most challenging aspects of autonomous air operations and safe and reliable flight control performance of unconventional airframes. Taranis was built for a comparatively modest budget (under £150 million) and is regarded as a clean break from the past, where budgets

were exceeded as a matter of course and delays and multi-national arguments over workshare were regarded as inevitable. Not any more, thanks to rapid prototyping methods and "smart" new production techniques that have incorporated lessons learned from developing new production systems for Typhoon and the F-35 JSF.

In fact Taranis is the first all-new, all-British, jet-powered military aircraft for 35 years, since the Sea Harrier. Everyone closely concerned with the project is at pains to explain that this is not yet a full-fledged combat aircraft. It is a demonstrator aimed at bringing together all the features - including stealth, endurance, potential Combat ISTAR capability, autonomous or remote control and affordability – that will be needed to develop an operational product that can fight and win tomorrow's wars. BAE Systems has pushed forward its experience in autonomous operations and low observability by developing and testing unmanned platforms that have steadily grown in size and capability so that today an Unmanned Air System is emerging that could cater for a wide spread of military needs, from the lightweight Herti, through the capable twin-engine Mantis, offering 20 hour endurance and a heavy payload of sensors or weapons, through to Taranis, a potential unmanned Tornado replacement of the future.

Named after the Celtic God of Thunder, Taranis is seen by many as one of the best hopes for Britain's aerospace sector to stay in the first league of military aircraft manufacturing. It is an example of how the country's aerospace sector is still world leading in advanced technology such as integrated systems, low observability, autonomous flight operations and hybrid structures and components. This new programme has the potential for making BAE Systems, Europe's centre of excellence for advanced UAS programmes. It is very significant that in reversing a trend extending back three decades, Taranis has been developed as a totally UK-managed project, retaining sovereignty on all key aspects. It is recognised within the UK aerospace community and MOD that this programme represents the highest standards in engineering and aeronautical design and its timing, which results from innovative and far-sighted research investment, is a rarity in an environment where there are very few all-new military air programmes under development in the UK beyond enhancements to Typhoon and a share in production of the F-35.

Taranis is quite a big aircraft for an unmanned platform, with a 30ft wingspan, and is similar in overall dimensions to a Hawk. Advanced computer aided design tools have been used to the full to provide a highly detailed virtual 3D digital model depicting every inch of the aircraft, to show panel access to vital components and systems, and confirmation of internal clearances. Mainland Europe's Neuron, being developed by a consortium including Saab and Dassault, under French management, looks remarkably similar, as do the Boeing Phantom Ray and the X-47B from the USA. But in important respects, especially its progress in the de-risking of advanced applications of innovative technologies, Taranis is probably ahead. Previous experimental programmes, involving a company investment of over £100 million, have quietly taken BAE Systems and its industrial partners to new heights in integrated autonomous UAS capability and Taranis represents the culmination of a massive effort to leap-frog rival UAS offerings. It is believed that its structure is largely comprised of machined metallic sections with composite panels and special coatings. The low observability requirements mean that aerials must be integrated into the structure. Although aimed initially at evaluating the practicalities and possible problems associated with autonomous operational missions, the Taranis demonstrator platform does not have a working weapons bay but built into the specification are onboard systems that can replicate in virtual form simulated attack missions. If the flight trials prove the general concept and design parameters, it is hoped that follow-up spiral development of the basic Taranis platform would allow for the fitting of actual weapons carrying capabilities.

Details of the aircraft are difficult to obtain as it is still shrouded in official secrecy, being the latest and most protected member of a family of highly classified "black" projects that have all been built at Warton in England and test flown in the remote Woomera test area in Australia, where BAE Systems has extensive ground control and monitoring facilities.

At the Warton Taranis roll-out event, Nigel Whitehead, Group Managing Director, BAE Systems, did not specify where flight testing would take place in 2011 after further systems integration and ground testing had been completed in the UK. He said many hours will be "flown" on the ground first in strict test conditions to de-risk the systems. Regardless of where Taranis makes its first flight, BAE Systems Australia is highly involved in the team effort and is supplying the flight control computing system. Another group company, BAE Systems Integrated System Technologies (INSYTE), is responsible for the vehicle's control infrastructure and the effective integration and interoperability of Taranis within the UK's operations and battlespace infrastructure. By July, over one million man-hours had been spent building the demonstrator. Taranis has arrived at a time when Combat ISTAR capability is said to be essential if the Royal Air Force is to retain an affordable but still significant air power role. This was underlined by ACM Simon Bryant, C-in-C Air Command RAF, who spoke at the event. Also, the UK aerospace sector is in need of a transfusion of new programmes if future export earnings are to be sustained, let alone expanded, as government ministers have indicated they wish to see. Speaking at Warton, UK Minister for International Security Strategy, Gerald Howarth MP had said, "Taranis is a truly trailblazing project. The first of its kind in the UK, it reflects the best of the nation's advanced design and technology skills and is a leading programme on the global stage".

The powerplant is a Rolls-Royce/ Turbomeca Adour 951 which is deeply embedded within the airframe to help eliminate radar returns. Rolls-Royce has completed the design, analysis and rig testing of the new propulsion system hardware and, with the majority of the components manufactured, is focussing on the instrumentation and assembly phases with bench testing to be completed by the end of this year. The company has also been engaged in other classified activity involving highly integrated power solutions which include provision for all the many onboard electronic systems and sensors. Any future production model would have an all-new engine optimised for the task. In the meantime, the Adour,

which the Indian Air Force uses in the supersonic Jaguar and subsonic Hawk, is well suited in size and thrust to power Taranis in much modified form.

£20 million was added to the original £124.5 million project budget to broaden the scope of the programme to provide further outputs with wider exploitation into manned fast jet aircraft. This includes additional risk mitigation activities "to enable full realisation of the programme objectives". If this programme should progress to fulfilling a future operational requirement it might lead to cross operations with other UAS platforms and manned aircraft, integrating data exchange with airborne command and control assets as well as ground stations. Accomplishing this in such a compact airframe is a huge challenge. The significance of this programme in the context of the UK having a long term future in combat air systems with scope to offer continuity in defence exports is regarded by the UK government as most important as such business, if the project remains under national management, would not be subject to US restrictions or veto.

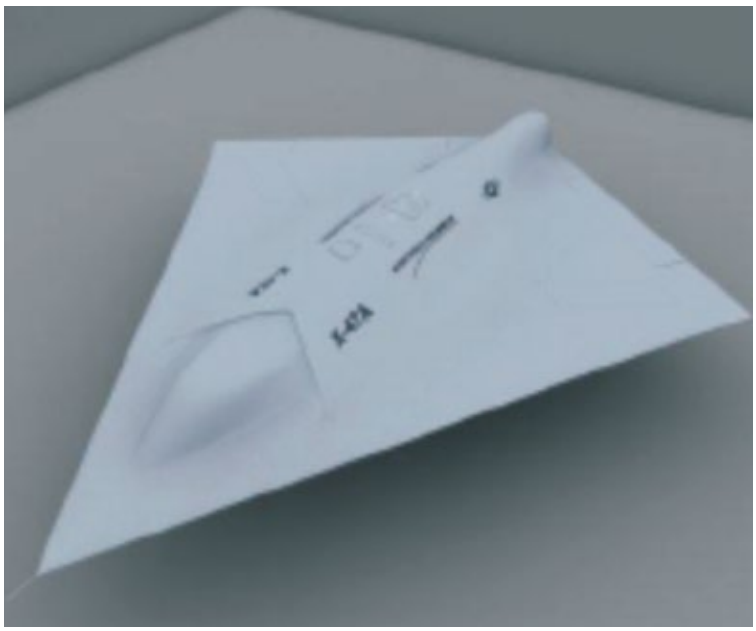
But Taranis is not yet a new RAF combat jet. As a joint MOD/industry technology demonstrator that has been designed and built using advanced methodologies and highly classified techniques, to de-risk and further evaluate the performance and reliability of a large turbofan powered unmanned air vehicle, it is a timely arrival on the UAS and combat scene. Apart from a small number of carefully controlled exercises in the USA and Israel, few large-scale experiments have been attempted to see how remotely piloted air systems can cross-operate under autonomous tasking conditions, alongside other manned air and ground assets in simulated operational conditions. Taranis will provide the UK MOD with evidence on the potential capabilities of this new class of long-range high speed UAV, helping to inform decisions on the future mix of manned and unmanned fast jet aircraft. Because of the challenges of automatically filtering massive quantities of data that future Combat ISTAR UAVs will be capable of collecting, analysing and distributing, it is thought likely that any future in-service systems will still have to be under the command of highly skilled ground or air based operators who will also be able to remotely pilot the aircraft. The time when fully autonomous air operations become a regular fact of life for major offensive operations is thus some way into the future, and will require further breakthroughs in software technology to reduce the human level of involvement. It will probably involve a gradual shift towards joint manned/unmanned missions in stages, as the technology delivers on the promise, rather than an immediate leap into the unknown.

If this exciting programme delivers the initial transformational capability expected, Britain's prospects for leadership in the emerging generation of advanced UAS programmes will rise by a significant degree. Much technical progress and preparatory operational analysis of future requirements has been undertaken successfully so far, but there is still much uncertainty concerning future government investment commitments at a time when the British forces are facing big changes over the coming years. Taranis won't be the single solution to difficult future RAF procurement decisions, but it may well prove to be a key to unlocking part of that dilemma - providing an impressively powerful and survivable deep-strike aircraft that is both affordable and effective. Such a product would have wide export appeal in the longer term.

Shapes of the present – and future.

UCAVs as a 'Grande Strategic' element for the PAF

Meinhaj Hussain, a Defence Analyst from Kuala Lumpur in his recent paper states that "the Indian Air Force is projected to induct a large number of 5th generation fighter aircraft within the timeframe of 2025" which, according to him, poses serious challenges for the numerically smaller Pakistan Air Force (PAF). The paper suggests UCAVs as a possible solution in countering India's military aviation superiority. "Pakistan can develop UCAVs in the same manner they developed the JF-17 to supplement 4th generation fighters" and enumerates on such an active and specific solution for PAF.



"If the Pakistan Air Force would avoid institutional and political barriers that the West is plagued with, they can make a relative leap in capabilities and meet their goals and objectives far better than a linear and asymmetric solution could. Pakistan has achieved a significant milestone with the JF-17. With a UCAV, Pakistan will have achieved the next major milestone. Pakistan's aircraft manufacturing industry would remain relevant rather than become outdated and relegated to obsolescence. The country does not have the technology or the resources to build an expensive and complex 5th generation plane. The UCAV however, is a far more achievable goal."

Taking a 15-year forward timeframe into account, Hussain feels India will begin to field PAKFA fighters from Russia and may also develop her own from technology bought from the Russians. While the latter may be discounted as another employment opportunity for the DRDO and related Indian bureaucracies, PAKFA and any specific–design built for India by the Russians will provide a challenge that would be wholly new to the subcontinent: a 5th generation fighter! Pakistan can either go bankrupt attempting to counter this new threat or she can become obsolete, back to a decade similar to the 1990s or it can develop UCAVs as a solution to its air defence needs.

A major political and geo-strategic situation in the offing could be winding down of the 'War on Terror' (WOT) in Afghanistan, which may result in aid from the United States and other Western countries drying up and Pakistan's Afghanistan leverage vis-à-vis the international community then drastically reducing.

A specific solution to fulfil the above requirements is investigated by the author. In his paper, Hussain designates either a J-UCAV or Joint UCAV, assuming a partnership at least with China, if not with other countries such as Turkey, Malaysia, Saudi Arabia, UAE, South Africa, Brazil, Argentina, Iran, Italy and others. The proposed solution is in the form of a well-swept delta, single-engined UCAV.

The J-UCAV design proposed in the paper makes the hypothetical assumption of using an RD-93 or a WS-13 / WS-12 sized engine, with a standard fighter aircraft engine as the benchmark to help allow the programme to use the engine parts of an existing system. Assuming the stringent requirements for metallurgy, advanced composites and other advanced materials and manufacture processes can be relaxed, degraded or substituted to an extent, the UCAV's engine can then perform adequately in the same thrust range with the tradeoff of degraded MTBF and reliability in lieu of low cost and simplicity.

Given the ability today of remotely launching AAMs and the highly sensor–rich environment over Pakistani air space in the timeframe of deployment, the UCAV would provide cheap force multipliers for Pakistan. There is some discussion among observers that at least some of the PAF's Mirage and F-7 fleets have been upgraded in a similar manner to launch BVR missiles, using input from external sensors through the C4I network. While there is doubt about the feasibility and usefulness of maintaining older jets in this role with due consideration to pilot training and maintenance costs, J-UCAVs would provide ideal substitutes and appear to be perfect platforms for this role.

"In this Grande Strategic view, the PAF can use large numbers of J-UCAVs as a cheap and ideal counter for the IAF and any other air force that seeks to undermine Pakistani airspace. They could form a picket line that are the first to deal with enemies and are reinforced with manned fighters where necessary. Such J-UCAVs would require very low maintenance, near zero training costs and may be cheap enough to not worry about being put outside hardened shelters, a valued commodity for the PAF. Armed with 2 BVRs and 2 WVRs, J-UCAVs could prove to become the foot soldier of the skies, lightly armed and yet overwhelming in their numbers."

Gains–and pains–for India's civil aviation industry

In late 2010, the International Air Transport Association (IATA), called for a more coordinated cross-ministry government approach to shoring-up the gains made in India's aviation industry. "Under the leadership of Minister Praful Patel, international flight frequencies to India have tripled to nearly 2,300 per week. India is more connected than ever to our globalised world, bringing enormous economic benefits. This has challenged all those involved in India's aviation industry to improve competitiveness. In recent years, there have been some great improvements. But there is still much more to be done. It's time for a comprehensive approach with a common vision by all involved," stated Giovanni Bisignani, IATA's Director General and CEO.

Bisignani noted the tremendous potential for Indian aviation which currently boasts a market of 42 million annual passengers domestically and a further 34 million internationally. "If Indians flew as much as Americans, it would be a market of over 4 billion passengers. With the spending power of Indians set to triple over the next two years, the potential for growth is incredible," said Bisignani. On the back of IATA's upgraded global forecast for a profit of $8.9 billion in 2010, IATA noted that while some of India's carriers are now reporting profits, the Indian sector as a whole is still expected to post a loss of $400 million. Moreover, it is carrying a debt burden of $13 billion. "In a market

as rich in potential as India, the precarious financial situation indicates that structural weaknesses must be dealt with," said Bisignani.

"India's rapid growth must be accompanied with a strong focus on safety. Establishing the Civil Aviation Safety Advisory Council (CASAC) is an important step forward. With IATA being a Council member, I strongly encourage CASAC to recommend that the IATA Operational Safety Audit (IOSA) is mandated for all India's carriers. IOSA has helped IATA's members achieve a safety record 2.5 times better than the global average. Taking advantage of this global standard will add a new dimension to India's safety oversight. Developments in Delhi are impressive. For the first time India has a hub that could rival Singapore or Dubai, with plans to accommodate 100 million passengers by 2030. But I have concerns on Mumbai. By 2016, stop-gap measures may take capacity up to 40 million. But where is Mumbai's 100 million passenger plan? We must find a solution that is environmentally responsible. The clock is ticking and a conclusion is urgently needed. Mumbai is a great city. However history tells us that no city can remain great without effective transport links. It is time for all parties to work together to agree on a site and get on with it," urged Bisignani.

An Air India Boeing 777.

"In stark contrast to Minister Patel's pragmatic liberalisation is the old world approach to foreign direct investment (FDI) in aviation by the Ministry of Commerce. India allows 100% FDI in transit systems, ports, harbors, hotels, ocean transport and road systems. But airline FDI is restricted to 49%. Moreover, no foreign airline can invest in an Indian airline. The inconsistency is difficult to understand. Does it make sense that a non-Indian airline can own 100% of a green field airport project, but cannot invest a single Rupee in an Indian airline? The success of India's airlines should not be compromised by an archaic investment policy that isolates them from global trends," said Bisignani, noting recent trends of consolidation, multi-hub and multi-brand strategies.

To build competitiveness, it is critical that the costs of operating in India are reduced. AERA—the airports regulator—has set a positive precedent by upholding ICAO principles and disallowing automatic cost increases for the airports in Delhi and Mumbai. But the Ministry of Finance has added $236 million to the cost of operating in India with an extension of India's 10.3% service tax from international premium tickets to economy and domestic travel as well, in contravention of the International Civil Aviation Organisation (ICAO) rules. "It is an embarrassing situation for such a relevant country as India—which is a member of the ICAO Council—to be ignoring rules that it has helped to develop," said Bisignani.

Bisignani noted a similar disconnect on security. Global standards, approved through ICAO, exist for the transmission of advance passenger information to governments for security purposes. "India chose to ignore these standards and invented its own unique requirements and processes. Moreover, local customs offices in Bangalore and Mumbai have added further local complications. Each deviation from the global standard adds costs but does not improve security. The Indian government has committed to develop a programme based on global standards with a single portal for transmitting data. The deadline for that has passed and we are still waiting. And to add insult to injury, airlines are now being threatened with fines for data transmission errors resulting from the complexity of the system," rued Bisignani.

The air transport industry has committed to improve fuel efficiency by 1.5% per year to 2020, cap net emissions from 2020 with carbon-neutral growth and cut net emissions in half by 2050 compared to 2005. "UN Secretary General Ban Ki-moon commended the industry's ambitious target as a role model. But we can only achieve our targets with a global framework agreed by governments under ICAO," stressed Bisignani. Bisignani re-assured that a global framework for aviation's emissions under ICAO was in India's best interests. "The United Nations Framework Convention on Climate Change (UNFCCC) has confirmed that a global agreement on aviation at ICAO will not compromise India's position on Common But Differentiated Responsibilities (CBDR) in non-aviation discussions. And the global solution on noise reached a decade ago under ICAO shows that the special needs of developing nations can be accommodated.

Kingfisher's Airbus A330-200.

"I am a great fan of India. To support the amazing developments that are happening under the leadership of Minister Patel, IATA continues to expand our India operations. Arriving at the New Delhi airport terminal, it was clear that this could be the decade when Indian aviation will reach its potential. But there are no guarantees for success without continued hard work, change and a common vision for success shared across government and with the industry. India has come a long way in addressing the challenges of growth. The foundations for success are half-laid and IATA will continue its support to help finish the job," assured Bisignani.

The World's Airlines

Meanwhile, the world's airlines are struggling to return to profitability after economic recession and collapsing air traffic which in late 2008 caused the airline industry to sink into a sea of red ink. The good news is that air traffic, especially in the cargo market, has been picking up since late 2009. This recovery has not been uniform throughout the globe, though, as the European and North American markets are lagging well behind such regions as the Asia/Pacific and the Middle East.

On the airliner manufacturer side, a new study released by *Forecast International* projects that a total of 11,844 large commercial jet transports will be produced during the 10-year period from 2010 through 2019. The Connecticut-based market research firm estimates the value of this production at $1.41 trillion in constant 2010 U.S. dollars. While it is no surprise that Airbus and Boeing account for over 98 percent of the forecast production, the study also indicates that emerging competitors from China and Russia may begin to make small inroads into the market by the end of the 10-year timeframe. In addition, Canadian manufacturer Bombardier's new CSeries family of 100-145 seat airliners will straddle the regional jet and large airliner markets, directly competing with Airbus and Boeing products.

Against this backdrop of continuing economic weakness and a still-struggling airline industry, Airbus and Boeing are facing two big issues. According to *Forecast International* senior aerospace analyst Raymond Jaworowski, "first, Airbus and Boeing have to determine how best to adjust production rates in response to market conditions. Second, they must decide on the scope and timing of new product development efforts in the face of competition from each other and new contenders such as the Bombardier CSeries."

Throughout the market downturn, both Airbus and Boeing have been fairly aggressive in keeping production rates high. While each made some early adjustments to build rates, they have largely declined to implement the deep production cuts, especially in narrowbody production that many observers have claimed are necessary. Indeed, both companies recently announced upcoming increases in narrowbody production.

At the same time, Airbus and Boeing have critical decisions to make regarding how best to reshape and refashion their product lines to meet the needs of the future market. In response to competition from the CSeries and others, Airbus and Boeing are considering marketing their current narrowbody families with new engines. Airbus appears more intent on this approach than does Boeing, which has indicated that it might instead launch an all-new narrowbody should Airbus re-engine its A320 single-aisle series.

Boeing also has a decision to make as on how best to respond to Airbus' new A350XWB. The XWB itself was a response to Boeing's new 787 Dreamliner. But rather than simply introduce a direct 787 competitor, Airbus ambitiously positioned the XWB to cover much of the payload/range spectrum that Boeing covers with both the 787 and the 777. Thus Boeing has been mulling whether it needs to upgrade or replace the 777 in order to stave off competition from the XWB. These product development decisions will have long-term consequences. As Jaworowski notes, "The product decisions that Airbus and Boeing make over the next few months will have reverberations for years to come."

Recaro

BIZJETS

Delayed but sure recovery forecast

Bombardier's Global 7000.

A recent study projects that (an exact) 11,437 business jets, worth an estimated $217.5 billion, will be produced from 2010 through 2019. *The Market for Business Jet Aircraft* also indicates that business jet production, which has dropped sharply since late 2008, will continue declining through 2011. A recovery in overall business jet build rates will not occur until 2012.

The study examines in some detail the various trends and factors that drive the business jet market, including changing nature of the fractional ownership industry. Aircraft demand from fractional programmes had helped spur the market to great heights in past years, but deliveries to fractionals fell off substantially in 2009. The fractionals are mainly concentrating on the operational side of their business in order to generate cost savings. New order activity by fractionals has been sparse during the downturn, but is starting to pick up. Meanwhile, the downturn has impacted the light and mid-size business jet sectors far more than it has the large-cabin and long-range segments of the market. While production rates of all types of business jets have been slashed since late 2008, the production cutbacks have been much deeper for light and medium jets than for the larger types. Demand is already starting to recover for larger, high-value business jets, but it remains moribund for small and medium models.

The projections indicate that the top three manufacturers in unit production during the 2010-2019 forecast period will be Cessna, Embraer and Bombardier. When the market is measured in terms of the monetary value of production, the top three are Gulfstream, Bombardier and Dassault. A slew of new business jets are on the way, as manufacturers are hoping that new products will stimulate market demand and kickstart the recovery. The top end of the market in particular is drawing considerable attention, with Bombardier recently launching its new Global 7000 and Global 8000 models to battle the Gulfstream G650.

In more detail

Bombardier Aerospace has introduced two new jets, the Global 7000 and Global 8000. The Global 7000 features a four-zone cabin, with a volume of 2,637 cu. ft. (74.67 cu. m.). The aircraft will have a high-speed cruise of M 0.90 and a range of 7,300 nm (13,520 km) at M 0.85. It will fly London-Singapore, New York-Dubai or Beijing-Washington non-stop with 10 passengers and entry into service is slated for 2016.

The Global 8000 will feature a three-zone 2,236-cu.ft. (63.32 cu.m) cabin and a range of 7,900 nm (14,631 km) at M 0.85. It will connect Sydney-Los Angeles, Hong Kong-New York and Mumbai-New York non-stop with eight passengers, Bombardier has revealed, and will be able to reach a high-speed cruise of M 0.90. Entry into service is scheduled for 2017.

"The Global 7000 and Global 8000 jets will give our customers the ability to reach more destinations non-stop than ever before" said Steve Ridolfi, President, Bombardier Business Aircraft. The new Global aircraft "will feature an all-new high-speed transonic wing, designed to significantly optimise aerodynamic efficiency, combined with next-generation GE TechX 16,500 lb. thrust-engines

Good Rich

to deliver significant efficiency and emissions advantages, including reduced NOx emissions – 50 per cent below the International Civil Aviation Organisation's upcoming Civil Aircraft Emissions Protocol (CAEP-6) regulations – and an eight per cent better overall fuel-efficiency target when compared to the industry-leading Global Express XRS aircraft," Bombardier has announced.

The Cessna Aircraft Company has introduced its Citation Ten, scheduled for first flight in late 2011 with first delivery and certification in 2013. The jet is a larger, advanced version of the Citation X, the Citation Ten having a 15-inch longer fuselage than the Citation X for more cabin space, winglets for more efficient performance, a new electrical system, dual lithium-ion batteries, new avionics, autothrottle, a redesigned cabin with new interior seats and cabin appointments, plus a proprietary fibre optic-based cabin management system including the latest interface options for greater in-flight productivity and connectivity. The aircraft boasts a 211 nautical mile (391 kilometres) increase in range at high-speed cruise, a 214 pound increase in maximum payload and a faster rate of climb direct to 45,000 feet.

The Citation Ten will use two new Rolls-Royce AE 3007C2 high-flow fan turbines, each rated at 7,034 pounds of thrust, the AE 3007C2 to be certified in 2013. "The launch of the Citation Ten is an example of our commitment, repeated throughout the recent downturn, to new product development, and is a signal that we intend to do what we need to do to maintain a general aviation industry leadership position," said Jack Pelton, Cessna's chairman, president and CEO. "We've teamed with Garmin and with Rolls-Royce to conceive an almost perfect combination of speed, performance, ease of operation and productivity in one airframe – the Citation Ten."

Now Piper Aircraft have unveiled the single-pilot PiperJet Altaire, featuring a larger redesigned round fuselage mounted on top of an expanded-chord wing, with a shorter vertical empennage located slightly aft atop an elongated engine nacelle. "The PiperJet Altaire is a powerful and stylish blend of efficiency, cabin volume, range, payload and speed," says Piper CEO Geoffrey Berger, the PiperJet Altaire is priced at $2.5 million.

The optimised configuration provides a cabin that is nine inches higher and four inches wider than the previous design. It will also feature a three-foot wide cabin door for ease of passengers as well as cargo. Piper targets a maximum range of 1,300 nautical miles for the jet, with a maximum cruise speed planned at 360 knots. The airplane is planned to fly 1,200 nautical miles with a full fuel payload of 800 pounds, according to the Company. The first four flight test aircraft will begin flight tests in 2012, with certification and deliveries planned to begin 2014.

Hawker Beechcraft Corporation has launched the Hawker 200, based on the Premier II which "will fly at 450 knots and 43,000 feet, with a range of 1,500 nautical miles with four passengers and a max cruising altitude of 45,000 feet."

"We've transformed the Hawker 200 into the fastest, most efficient and most spacious, single-pilot certified light jet you can buy," claims Shawn Vick, HBC executive vice president. "After tallying up the changes, there was no question that this business jet had graduated into a new class." The aircraft will feature winglets, new Williams International FJ44-3AP engines, a gross weight increase and a higher ceiling as well as a MultiScan Weather Radar and ADS-B Out capability. The aircraft made its first prototype flight in March 2010, and has logged more than 100 hours in flight test. It is scheduled for certification in the third quarter of 2012, with first deliveries planned for the fourth quarter of 2012.

Hawker Beechcraft's Hawker 200.

Airworks

Alenia Aeronautica's tactical transport aircraft C-27J Spartan.

Visiting Finmeccanica, in Italy

In November 2010 the *Vayu Aerospace Review* was with the Italian Company, Finmeccanica for a 'Familiarisation Visit' to all the companies under their banner in Italy. We were warmly welcomed in Rome by Livia Buttarelli and Riccardo Acquaviva, both of whom were to accompany us during our visit.

Our first day started at the Head Office with a company presentation by Riccardo Acquaviva, Vice President, International Media and Trade Press and we were then addressed by Giovanni Soccodato, Senior Vice President, Finmeccanica Strategy Department, who reviewed the company's activities and strategies, focusing on India. We went to the Selex Sistemi Integrati site, for presentations by Sergio Iacono, Senior Sales Manager, Asia Pacific and shown around the 'Large Systems Centre of Excellence', Demo room, followed by a visit to the Naval Integration Centre.

The next day we returned to the Finmeccanica Head Office for a presentation on Selex Communications after which Fabrizio Giulianini, CEO and General Manager gave a presentation for Selex Galileo. Later, we headed to the Alenia Aeronautica site where the CEO Giuseppe Giordo addressed us. We then boarded the train to Livorno, which however sped through the station, not stopping until it had reached Pisa from where we made our way back to Livorno!

We went to the WASS site where torpedoes and missiles are manufactured and had a presentation from the CEO, Renzo Lunardi, followed by a look at the missiles on site. WASS is currently working with the Indian Navy. Another supplier for the Indian Navy is OTO Melara, who make naval guns and tanks. At their site in La Spezia we were shown around their production facility.

From Livorno we drove to Turin Caselle and the next morning we transferred to the Selex Galileo facility where we were briefed on Air Systems, UAS and Simulators. Next stop was Alenia's Caselle Facilities North Plant, where we had a very interesting tour of the final assembly line for the C-27J Spartan and the Eurofighter Typhoon wings production. We transferred to the South Plant for lunch before boarding our flight on the C-27J transport plane for a demonstration flight cum transfer to Venegono, where the Alenia Aermacchi facility is situated.

At Alenia Aermacchi we were briefed on the M346 advanced jet trainer and given a tour of the M346 production line. We travelled by bus from Turin Caselle to Milan Malpensa to our last stop of the visit. The following morning was spent at Agusta Westland's helicopter site for presentations by Gianluca Grimaldi and we were shown around the final assembly production and flight lines. From there we transferred to Milan Airport and were finally heading back to India after a packed, very interesting and informative visit to the Finmeccanica companies in Italy.

Finnmecanica

Finmeccanica and India

During its more than 40 years of activity in India, the Finmeccanica Group has partnered the country in many of its pioneering development projects, supplying radar and communications systems, helicopters, plus land and naval defence systems. The Group's most significant presence on the Indian market relates to the activities of Ansaldo STS, which set up a division in Bangalore in 1996 with the aim of supplying signaling automation and control systems to South Asian markets and offering engineering support to Ansaldo STS group companies operating in the region. Ansaldo STS' industrial presence in India consists of around 350 highly-skilled employees, who are an important asset of the Finmeccanica Group's human resources operating in India (about 400).

Finmeccanica sees India as a "strategic market" and the Group's offices in New Delhi are testament to the increasing attention being focused on the country, with a view to making a decisive leap forward in the Group's relations with local partners. The main objective is to transform India from a simple commercial outlet into a skilled collaboration with which the Group can establish stable and strategic partnerships involving local companies in the belief that it is important to maintain a continuous and deep-rooted presence in a country with extensive sharing of technology and expertise, rather than simply to sell individual products.

To make its strategic development objectives a reality for the Indian market, the Finmeccanica Group has already launched a number of partnerships, while plans are for other specific joint projects with Indian companies such as Alpha Design Technology, BDL, BEL, BHEL, HAL, and Mahindra & Mahindra, are currently being considered. AgustaWestland has already taken a significant step in this direction with the creation of the joint venture with Tata Sons for final assembly in India of the single-engined AW119. Another area of strength is Ansaldo STS' confirmed leadership on the Indian signaling market, with a market share of more than 80% and operations stretching from India and Bangladesh to Sri Lanka and Myanmar.

SELEX Sistemi Integrati produces large Homeland Security systems, combining the experience of all the Finmeccanica companies within network-centric operating environments, designed for the protection of national borders, roads, ports, airports, railway stations and critical infrastructure. In addition, the company can provide the Indian Armed Forces with combat systems for naval units, C3I and C4I systems for land applications and surveillance and fire control radar systems. Present in India since 1972, SELEX Sistemi Integrati has been working with BEL (Bharat Electronics Limited) to supply the country with radar systems for air traffic control. The most recent contract concerns the installation of complete systems at the international airports of Bangalore and Hyderabad. In the naval sector, SELEX Sistemi Integrati boasts a presence dating back almost 30 years in India, represented by its command and control system on board *Godavari*-class frigates. The company also supplies the PAR 2080C (Precision Approach Radar) system to the Indian Navy and Air Force.

SELEX Communications has a presence going back 20 years in India, where it supplies avionics, tactical and naval communications systems, either directly or in partnership with the leading local companies HAL and BEL. SELEX Communications is also involved in some of the major programmes underway in India relating to tactical communications and the telecommunications components of Battle Management systems. In the near future, SELEX Communications could provide the Indian Armed Forces with its expertise in protected military communication systems.

The Selex Galileo Vixen 1000ES AESA radar.

SELEX Galileo supplies more than 60% of the Eurofighter's avionics and mission critical systems and has a proven ability to deliver value added and technology intensive capabilities and support solutions. The company offers highly successful ISR (Intelligence, Surveillance, Reconnaissance) solutions such as the ATOS mission management system which integrates the Seaspray surveillance radar family. SELEX Galileo has unrivalled airborne AESA technology and range of products for current and future requirements in the military and surveillances domains. SELEX Galileo delivers highly effective Airborne self-protection and situation awareness systems, currently operated by world wide customers on a range of fixed wing and rotary platforms. SELEX Galileo delivers full situation awareness, and force protection to land forces with its Electro optic and

AgustaWestland will supply 12 AW101 helicopters to the Indian Air Force.

Acoustic solutions. The Company, which has been operating the Mirach 100/5 targets at the national Integrated Test Range since 2007, is poised to sell complete target drone systems.

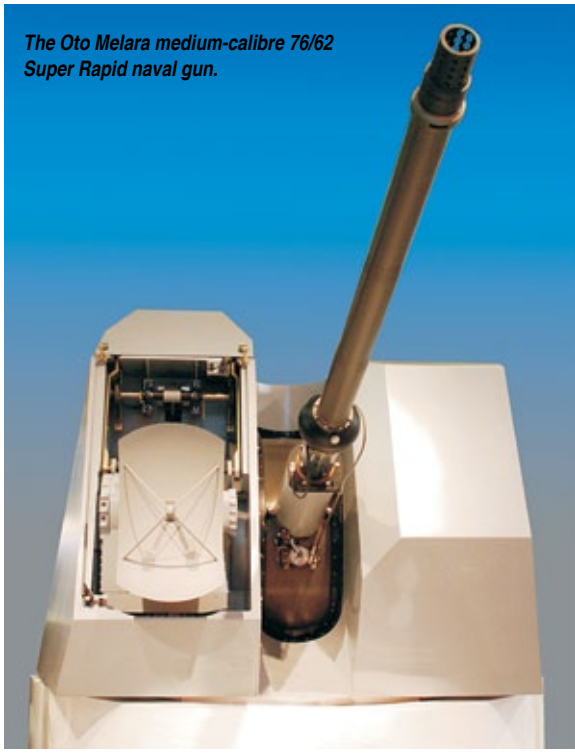
DRS Technologies offers the Indian market ultra rugged solutions such as the ARMOR C12 Convertible Notebook and the X10 Rugged Tablet PC for data presentation and processing that can operate even in extreme environmental conditions and highly critical operational theatres. DRS' flat panel class of military display computers, advanced tactical displays and integrated workstations boast a strong history of proven battlefield performance. DRS has provided the Indian Coast Guard with flight data registration systems for the detection and recovery of missing aircraft and the analysis of critical data. Multi-and Dual-Display Navy Workstations provide long-lasting, operational workspaces that allow the operator to assimilate and react to new information in a fast-paced operational environment.

AgustaWestland has been present in India since 1970, supplying Sea King helicopters to the Indian Navy. Recently, the company was awarded the contract to supply 12 AW101 helicopters to the Indian Air Force for VIP transport duties. The company has also established a joint venture with Tata Sons to set up a final assembly line in India for the AW119 light helicopter. Looking at the present and future needs of the Indian Armed Forces, AgustaWestland "is able to meet their every requirement", with models such as the AW119 LUH, AW139, NH90 and AW101 for land or sea missions. Furthermore, AgustaWestland is expanding its presence in India's commercial market, with almost 40 aircraft sold in just a few years, including the AW119, AW109 Power, providing in-country maintenance for its local customers.

Alenia Aeronautica is offering the C-27J Spartan tactical transport aircraft for a variety of missions, including transport of troops, paratroopers, search & rescue, logistical supply, humanitarian assistance, fire fighting and other missions. Alenia Aeronautica is participating in the M-MRCA (Medium Multi-Role Combat Aircraft) tender with the Eurofighter Typhoon. Led by EADS Germany, this campaign is followed with close interest by Alenia Aeronautica, which has made crucial contribution to the development and production of the Eurofighter Typhoon.

In the civil aviation arena, Finmeccanica has registered great success with its ATR42/72 regional airliner family produced by the joint venture between Alenia Aeronautica and EADS, which has had great success in recent years throughout the world, including India, where around 100 aircraft are in service. Special versions of the turboprop developed by Alenia Aeronautica, the ATR72 ASW (for anti-submarine warfare) and the ATR42 MP (for maritime patrol), are tailored to meet specific requirements. In the field of pilot training Alenia Aermacchi offers a complete range of aircraft and services, which include the SF-260TP basic trainer, the M-311 intermediate jet trainer and the innovative M-346 'Master' advanced trainer.

WASS, which has operated in India since 1976, provides the *Black Shark* heavy-weight torpedo for Scorpene submarines and new versions of its light-weight torpedo A244S, as also the advanced anti-torpedo counter measure systems C303S and C310 for submarines and surface ships. The company has been working for some time in partnership with BDL (Bharat Dynamics Limited).

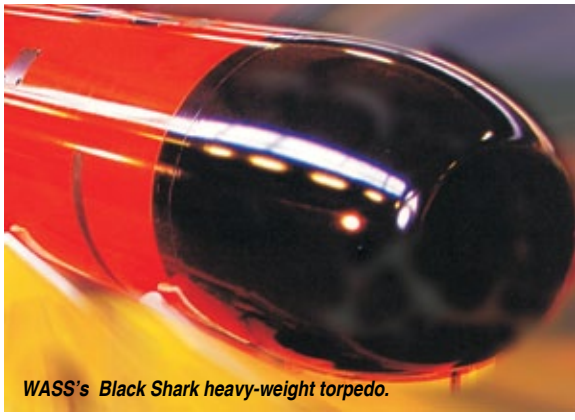


The Oto Melara medium-calibre 76/62 Super Rapid naval gun.

Oto Melara is the market leader in India with its medium-calibre 76/62 Super Rapid naval gun, produced under licence by BHEL (Bharat Heavy Electricals Limited) and the company is promoting its 127/64 LW naval gun, DART guided munitions, Vulcano (both for sea and land used) and small-calibre naval guns. Oto Melara's wide-ranging portfolio of land systems, comprising heavy-medium-and small-calibre turrets which can be both adapted for new armoured vehicles, both tracked and wheeled and used to update existing ones, are also of potential interest to the Indian armed forces.

Avi Sodhi

Alenia Aeronautica is participating in the M-MRCA campaign with the Eurofighter Typhoon.



WASS's Black Shark heavy-weight torpedo.

SELEX Galileo:
New focus in electronic warfare

Richard Gardner visits SELEX Galileo's new headquarters in Luton, UK where the strongest specialist capabilities of two of Europe's leading defence electronics companies have amalgamated to create a new centre of excellence for electronic warfare systems.

The name SELEX Galileo may be less familiar in defence circles than some of its rivals in the electronic warfare market, but within the combined corporate identity of this Finmeccanica Company reside the names of a long established line of British and Italian engineering and avionics companies. A fusion of SELEX Sensors and Airborne Systems Ltd in the UK and Galileo Avionica S.p.a. of Italy, the 100-year heritage of SELEX Galileo is impressive and represents the successor to such respected names as GEC-Marconi, Ferranti, FIAR, Alenia Difesa, Meteor and Galileo Avionica.

With attention in defence decision-making communities now turning away from sheer firepower issues to those concerning increased situational awareness, survivability and network-enabled force integration, the company is well placed to consolidate its strong position on a growing number of major European defence programmes, and to increase its exports and overseas partnerships. So far, customers are spread across 70 countries, but the increasing customer demand for partnering solutions to meet future needs is well recognised and is being actively addressed on major programme proposals. The operations undertaken within the company's business structure comprises air systems, electro-optics and naval systems, electronic warfare, situational awareness and battlespace protection, radar and advanced targeting and space.

Dr Beatrice Nicholas is Senior Vice President, Electronic Warfare business at the company, and spoke to *Vayu* recently during a visit to the new development and production facilities. "There are over 7,000 people employed in the company, the largest number (over 4,000) in the UK at Luton and Edinburgh, and nearly 3,000 in Italy. With over 1,000 at Luton, this is Europe's largest Electronic Warfare centre of excellence and the third largest in the world," she said. "We have a high skills capability with a commitment to complex systems integration and support" and added that " we also have a strategic partnership with the UK Ministry of Defence and a very close working partnership with industry and the UK armed services."

An indication of the scale of activity currently underway can be seen in the company-released figures, with an orders backlog worth some 4.3 billion Euros. Within the Finmeccanica Group, defence electronics represents nearly 30% of revenues by sector. Activities range from microelectronics, microwave, software engineering and digital technology. The SELEX Galileo focus is on leveraging these technologies and products to meet military needs, especially defensive aids and enhanced situational awareness capability on networked platforms. This is achieved through such integrated solutions in surveillance, imaging, tracking and target protection as well as navigation control. Meeting these requirements involves developing new products in infra-red, system architectures, E-scan and M-scan technologies, laser, detectors, thermal imaging, processing and unmanned systems. Much of this work and investment in new solutions now extends beyond conventional applications for air, land and sea defences, into the increasingly demanding needs for border surveillance, anti-terrorist defences and homeland protection. This is opening up whole new areas for technology exploitation as governments realise that tomorrow's threats to national security may be very different to what was in the past. The recent *UK Strategic Defence and Security Review* recognises that this is the case and is increasing expenditure on countering, for example, cyber threats.

Environmental testing lab.

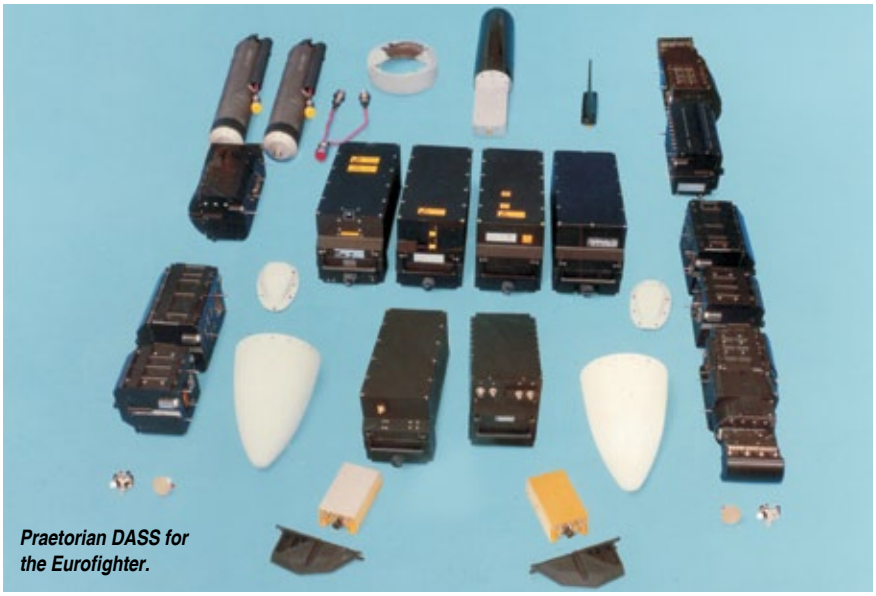
With high levels of NATO operational activity in Afghanistan, against a serious threat from hostile ground elements, it has become essential to equip fixed wing aircraft, including transport and helicopters, with a range of effective self-defence measures. SELEX Galileo is at the forefront of developing and supplying such systems. One of the main markets for the company at the moment is self protection systems for helicopters and this

is being expanded with the development of more compact systems intended for unmanned air vehicles.

In February 2010, the UK MOD awarded a 4-year contract to SELEX Galileo to lead the Common Defensive Aids System (CDAS) Technology Demonstrator Programme aimed at supporting the UK's strategy for air platform protection. This involves the provision of a coherent cross platform approach to both the acquisition and support of defensive aids suites for new and legacy helicopters. The programme will deliver an open DAS architecture so that it can be adapted to platform and role specific configurations which will allow for easy future upgrades and enhancements as operational and obsolescence dictate. In parallel with this work, the CDAS TDP programme will address the UK's need for cost effective solutions while retaining operational sovereignty. This will build on the experience from existing legacy equipment while integrating new sub-systems with the results being proved in bench tests as well as flight trials.

Project Baker and HIDAS

Within a new programme known as *Project Baker*, the company has been responsible for an upgraded Integrated Defensive Aids System for the RAF's Mk2 and Mk3 Chinook helicopters, which have been playing a key role in the supporting ground troops in Afghanistan. The Urgent Operational Requirement to upgrade the Chinook DAS equipment represented a £10 million contract to bring the new system into use as soon as possible. Utilising existing EW equipment alongside a new Multi Function Display (MDF), brings benefits in control and threat coordination by using the company's HIDAS controller. This coordinates the threat data and accompanying sensor information to provide the crew with a combined threat and status image via the MFD. This has now entered UK service. HIDAS has become an essential survivability and situational awareness tool on British military helicopters. The data gathered from all the multi-spectral sensors is fused with the user-defined Mission Data Set (MDS) and creates a comprehensive tactical picture of the operating environment. This creates unparalleled situational awareness to the crews and gives optimum self-protection to the aircraft platform by rapidly identifying hostile weapon systems and initiating appropriate tactics and countermeasures. The mix of sensors depends on the helicopter type and its role, and the HIDAS package can be scaled accordingly. The components can include a radar and laser warning receiver, a missile warning system, countermeasures dispensing system, DAS controller, Directional Infra-red Countermeasures (DIRCM) and backing up the onboard systems, along with electronic warfare operational support facilities. For the pilot, the HIDAS provides automatic protection as it rapidly detects, identifies, prioritises and then counters the most immediate threats. The HIDAS is operational with British Army Apache attack helicopters and will form the integrated defensive aids system, HIDAS-15, for the new AW159 Wildcat helicopters now on order. This will be supported by a Mission Data Generator for electronic warfare operational support which will provide trained users with a facility to construct theatre specific data using sovereign EW inputs. This system includes the ability to replay mission data that is captured by the DAS controller. Unknown emitters that are detected during a mission can be analysed using the recorded data, the output of which can then be used to update and improve the MDS.



Praetorian DASS for the Eurofighter.

Testing Praetorian LRIs.

SELEX Galileo's plant in the USA has recently completed the first 12 Aircraft Gateway Processor units to Boeing for installation on the US Army and International Block II and Block III AH-64D Apache helicopters. This upgrade to situational awareness has been adopted

for inclusion on all Apache deliveries to US and export customers.

SEER is a next generation digital Radar Warning Receiver designed for modern fixed wing platforms. It has enhanced processing power, is capable of identifying and prioritising complex RF signals in a hostile threat environment and is currently undergoing flight trials on a variety of aircraft types. It can be retro-fitted to replace existing RWR systems or integrated onto new platforms and gives a considerably enhanced detection range. More importantly it has also reduced life-cycle costs through improved reliability. Its threat library is flight-line programmable and is designed to offer a seamless upgrade for existing customers.

The Electronic Support Measures and Laser Warner together with an active Missile approach Warner work together with the Typhoon's on-board sensing systems to give maximum warning and identification information to the pilot. The Electronic Countermeasures System is automatic and activates the most suitable counter to the threat while the data is displayed on the cockpit multi-function displays. This gives the pilot the option of a manual over-ride if required. The ECM incorporates Digital radio Frequency Memory technology with a range of jamming techniques. The Praetorian system has an innovative active countermeasures capability, Ariel, using two fibre-optic towed RF decoys. This provides the most comprehensive

The HIDAS is operational with British Army Apache attack helicopters.

The BAE Hawk AJT is seen as a natural platform for the new system.

The Eurofighter Typhoon is being offered to air forces the world over, including India, where there is a requirement to replace earlier generation multi-role fighters. An important feature of this combat aircraft is its Praetorian Electronic Warfare suite, designed and supplied by the SELEX Galileo–led EuroDASS consortium, to provide 360 degree protection against air-to-air and surface-to-air threats. The self protection system carries out threat detection and evaluation before it automatically activates a countermeasure response. The system is internally fitted and comprises spherical threat warning.

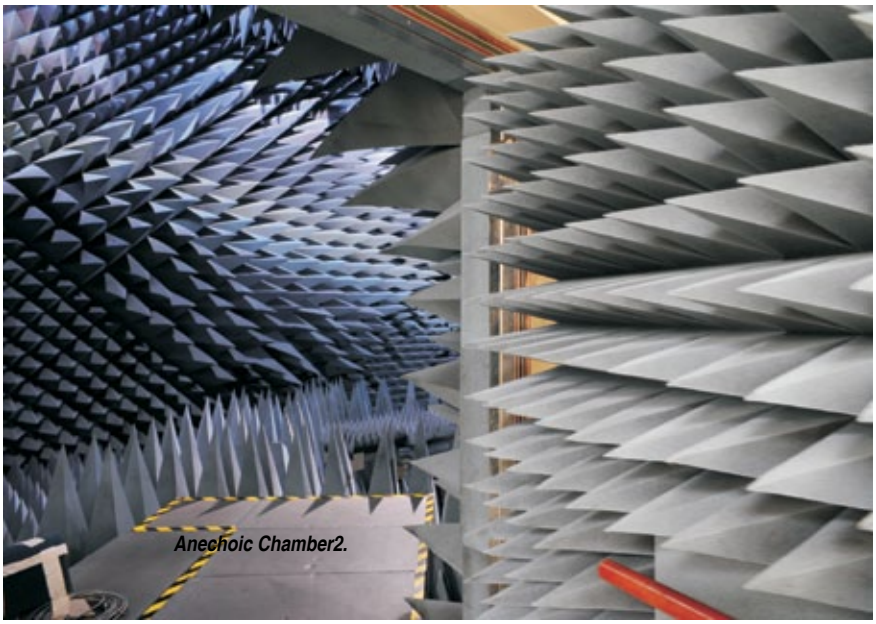
angle deception ECM currently available to overcome monopulse radars, semi-active missiles and home-on-jam systems. These countermeasures are more robust and effective than conical scan deception, cross-polar and cross-eye jamming and give an extended operating window compared to passive countermeasures such as chaff and flares. Proven in combat on RAF Tornado aircraft, the system equips Typhoons in RAF, German, Italian, Spanish and Saudi Arabian service. There is a low false alarm rate using proven clutter rejection techniques. The re-programmable central processor has been designed to support future growth modifications and the system currently offers a unique ability for a towed device to operate over the entire fighter flight envelope, including full power and high G manoeuvres.

Protecting UAVs

Many of the EW techniques developed by SELEX Galileo have multiple applications and in the field of integrated self protection systems designed for helicopter use, the future requirement to give unmanned vehicles added cover has been recognised. At first, UAVs were considered relatively safe from ground fire as they usually operated at an altitude and often at night. However, as many UAVs are now armed and used more frequently in the close air support role, or for destroying identified targets of opportunity, self-protection systems need to be fast reacting and fully automatic as there is no onboard pilot to decide when to react, and ground-based operators might not be able to react quickly enough when a serious threat to the air platform emerges. Modular software is used in these systems so the interfaces can be changed in configuration and are platform agnostic - meaning they can be adapted to fit most air platforms, fixed wing or rotary wing. The customer can define the data to be used so the defensive suite can be designed to incorporate whatever is most needed, such as long-range warning of missile attack, or even gunfire or rocket attacks at low level. A lot of work has gone into investigating the best way to

protect low flying helicopters from hostile ground fire and this will be applicable to UAV applications as well. 'Eclipse' is a new flexible common defence system with modular configurations featuring multiple sensors around the platform. Experience from the production of Sky Guardian systems used on UK helicopters is being incorporated to the RAF's Puma upgrade programme which is expected to enter service around 2014.

In the coming years, more variations on the DIRCM and HIDAS themes will emerge from the company, with improved sensitivity and signal processing to meet emerging operational needs. Platform applications are already spreading to tactical transport aircraft (such as the C-130J and C-27) and will become standard on more and more helicopters. The smaller UAV platforms create engineering challenges concerning power supplies and cooling requirements on lightweight airframes, and antenna design, but miniature systems will be scalable and in due course may become a more affordable fit on these platforms. Cooling can be by air or liquid and very configurable solutions are being examined that might be as light as 10kg. Trials on a UAV system known as SAGE have not yet flown on a UAV platform but are undertaking flight trials on a light Squirrel helicopter. The next series of trials will take place on a twin-engined light Piper Navajo aircraft. An important aspect of developing successful UAV EW systems is the need to have real-time networked data distribution so multiple observers can consider the operational situation. Distributed solutions are attractive to larger platform manufacturers for new aircraft and retro-fitting to older types. This is the market that is sure to keep on growing.



Anechoic Chamber2.

'Glorious Wake, Vibrant Future':

Excerpts from the speech by Chief of Naval Staff, Admiral Nirmal Verma on Navy Day

"Navy Day is an occasion to remember our war heroes and rededicate ourselves to the service of the nation. Since the past twelve months, the Indian Navy has pressed forward towards enhancing maritime security and safeguarding our economic and strategic interests. Today, the Indian Navy stands committed to providing stability not just in the Indian Ocean Region, but also ensuring unhindered access across the oceans, wherever our interests may lie.

Over the past year, we have maintained a high tempo of operations. Our ships, submarines and aircraft have conducted sustained operations towards safeguarding our maritime interests. We have operated in tandem with navies of friendly nations in the form of naval exercises, as well as cooperative security initiatives in support of our foreign policy along with consolidating our coastal security organisation and infrastructure. In addition, we have steadily moved forward in our quest for greater indigenisation of our equipment along with nurturing of our human resources.

Generation of a modern force structure capable of undertaking maritime missions across the entire spectrum of operations has been our focus area. Presently, there are 36 ships and submarines on

Building a 21st Century Navy

The Indian Navy's original fleet requirements unit (FRU), now INAS 550, based at INS Garuda with Dornier Do-228s and Islander 2Ts is tasked for observer training, communication and maritime patrol.

order in various Indian shipyards. Our ship and submarine building programmes are largely on-track. Amongst the major projects, the construction of our Indigenous Aircraft Carrier at Kochi is progressing satisfactorily, though with some hiccups, and the refurbishment of INS *Vikramaditya* at Russia is doing well.

In terms of force development, our first stealth frigate, the INS *Shivalik*, is already in commission, and two more ships of the class will soon be commissioned. Other significant programmes in the pipeline are three *Kolkata*-Class destroyers, four advanced anti-submarine corvettes and six *Scorpene*-Class submarines. Four modern Offshore Patrol Vessels and our second sail training ship are at various stages of construction. Orders for five Offshore Patrol Vessels and two Cadets' Training Ships have also been placed on private shipyards. The Government has also accorded approval to induct four Landing Platform Dock ships or LPDs under 'Buy and Make Indian' clause and six submarines under Project 75 India. Among the inductions planned from abroad are the Carrier INS *Vikramaditya*, three follow-on ships of the *Talwar*-Class from Russia and two replenishment tankers from Italy. The first of the tankers is likely to arrive in India by end December 2010 and will be delivered by early 2011.

The Indian Navy is focussed on achieving self-reliance through indigenisation. Towards this end, we are committed to supporting our indigenous shipbuilding industry. The response from both public and private shipyards for the Navy's requirements has been encouraging,

Sea King Mk.42B of INAS 330 comes into land on INS Viraat.

owing to which our force levels will see an upward trend. New ships will continue to be inducted at regular intervals.

The *Vikramaditya's* induction has been delayed due to increase in the scope-of-work, which consequently led to an unavoidable upward revision in price. Significant progress has been seen, especially over the past few months and all efforts are being made to ensure that the *Vikramaditya* is delivered by December 2012. We are fully seized of the significance of the project and both sides are doing their best to affect timely delivery of the ship.

In the interim, Mid-life Upgrades (MLUs) of 13 ships has been approved and the ships are being upgraded accordingly. After their MLU, the already very capable ships of the *Rajput*-Class, as also those of the *Godavari*-Class, will emerge as significantly more capable and modernised 21st Century combatants.

In order to enhance our surveillance capabilities, twelve P-8I Poseidon Maritime Patrol Aircraft are planned for induction. During my recent visit to the US, I had the opportunity to personally review the progress of this project and I am happy to state that the production of the aircraft is well on track. These are extremely modern and capable aircraft and will enhance our surveillance, anti-surface and anti-submarine preparedness significantly. Delivery of these aircraft is expected to commence in January 2013. We have also initiated the process to acquire Medium Range Maritime Reconnaissance aircraft to further augment our surveillance capabilities.

The Navy's Carrier-borne fighter aviation has also seen added impetus with induction of the first batch of MiG-29K aircraft in February 2010. Our aircrew are already flying the aircraft and an Intensive Flying Training Unit has been set up to complete the task in a time-bound manner. Recently, an additional contract for 29 MiG-29K fighters has also been signed. Our indigenous naval fighter programme marked a significant milestone this year, with the first 'roll out' of the naval version of the LCA on 6 July at Bangalore.

The Navy is also in the process of procuring 16 Multi Role Helicopters to augment the surveillance and attack capabilities of ships. Procurement of the Naval Utility Helicopter, as a replacement for our Chetak fleet, has also been initiated. The existing fleet of Sea King and Kamov helicopters is planned for a Mid Life Upgrade in order to provide them with a sophisticated sensor suite. All these steps would supply the requisite fillip for the Naval Air Arm to be even more effective in its assigned tasks.

We also have an indigenously developed data link and combat management system. It is a matter of great pride for us that a large percentage of the systems being inducted on ships are indigenous. It is even more heartening that some of these have a fair amount of in-house R&D contribution by naval personnel.

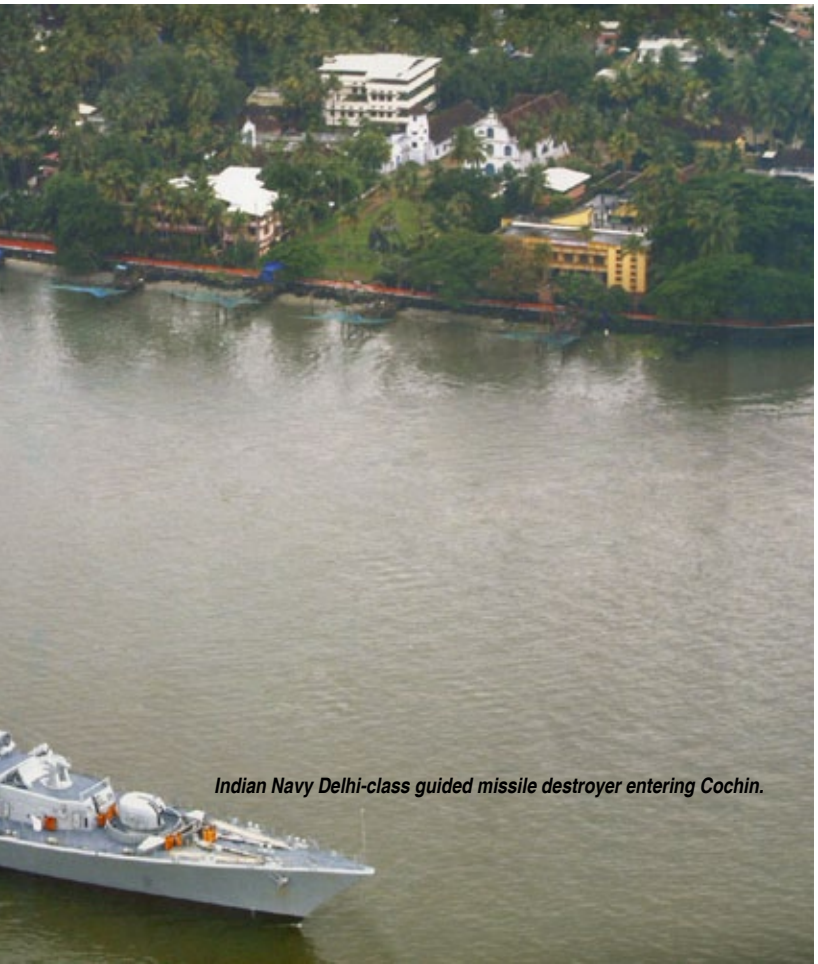
Our expanding maritime interests require a growing Navy. To cater for such growth plans, we also have had to put new infrastructure in place. These include a second phase of expansion of

the naval base at Karwar, planned induction of a second floating dock and upgradation of our dockyards and aircraft repair yards, to keep pace with new inductions and ensure infusion of new technologies.

Coastal security is a key area in our overall maritime security architecture. In this regard, one of the most significant achievements of the last year has been the integration of all maritime stakeholders, including the several State and Central agencies into the coastal security matrix. As a result, there is today far better coordination, synergy and understanding among all agencies. Intelligence and information sharing has undergone a transformational change. Real time information flow among all stakeholders has resulted in more effective and rapid response by the seagoing agencies to a developing situation.

MiG-29K of INAS 303.

The Indian Navy had established four Joint Operation Centres at Mumbai, Visakhapatnam, Kochi and Port Blair. In addition, the state Marine Police and other agencies such as Customs, Intelligence Bureau, Ports, etc. are also networked with these centres. Besides these, each coastal district is under an Area Operations Centre for coordinating coastal security activities. In addition, coastal security exercises have been conducted in every coastal state in conjunction with the Coast Guard, marine police, customs, immigration and Port authorities to achieve and maintain a high level of synergy. In all, ten exercises on the West coast, nine on the East coast, two in L&M islands and two in A&N Islands have been conducted in 2010. During these exercises, several contingency scenarios were simulated and all agencies with a stake in coastal security participated, with a view to improve coordination, achieve integration and improve the coastal security mechanism even further.


Indian Navy Delhi-class guided missile destroyer entering Cochin.

In a focused drive to increase the awareness of our large fishing community and integrate it into the coastal security matrix, 89 awareness campaigns were conducted, covering all coastal districts. This is an ongoing endeavour, and will be continued in the years ahead.

Improving our awareness of the maritime domain is imperative to maritime security. I am of the view that attaining awareness of the maritime domain is not a localised action to be undertaken by a single agency, but one that requires participation of many agencies at the national level including the Navy and Coast Guard, government departments concerned with maritime activities, governments of coastal states and island territories, law enforcement and intelligence agencies, and other stakeholders in maritime security.

Towards creating a common information grid to synergise the efforts of all stakeholders, an Approach Paper for achieving comprehensive Maritime Domain Awareness, was formulated by the Navy in March 2010. The concept of National MDA was approved by the National Committee for Strengthening Maritime and Coastal Security (NCSMCS) on 10 April 2010 and subsequently, the Navy has formulated a Detailed Project Report for implementing it as a national project. Once implemented, integrated National MDA will enable effective sharing of maritime related information among all stakeholders,

INS Sindhurakshak (Kilo-class) submarine with Chetak

thereby leading to more informed decision making and faster response by security agencies. I had mentioned last year that this would have high priority in the Navy's agenda for this year. I am happy to report that we have maintained our timeline in this complex, but extremely important endeavour.

While I have spoken at length about the progress made in enhancing our coastal security, I wish to emphasise that we have not neglected our blue water operations, and the Indian Navy continues to sharpen its capabilities through regular fleet exercises, both within the Navy, as well as with our major international partners. Suffice it to say, that our powder is dry and we stand ready to combat any mala fide activity intended to harm our national integrity and interests.

As India's development is predicated on a stable geo-strategic environment, it is in our interest that we play an active role in this regard, based on the twin principles of cooperative security and shared prosperity. The Indian Navy has developed excellent professional relations through maritime interactions with regional as well as extra-regional powers. There is almost universal acceptance of the Indian Navy's credentials and recognition of the vital contribution that we can make towards the security and prosperity of the entire region. Drawing on our human resources and technical expertise, the Indian Navy is involved in both capacity and capability building of our maritime friends in the region. We are also the hub for hydrographic training in the IOR.

We are proud of the fact that the Indian Navy has emerged as a versatile and flexible diplomatic instrument for the country. Our initiatives have included MILANs at Port Blair which is attended not only by the South and SE Asian navies, but from even farther afield. We also have the distinction of undertaking naval exercises with all the

major navies of the world, with 13 such exercises being held in 2010.

The Indian Ocean Naval Symposium (IONS), launched by Indian Navy, has provided a forward-looking framework for constructive engagement amongst navies of the region. This initiative has tremendous potential as an inclusive forum for all stakeholders that have legitimate interests in the region. The IONS has a membership of almost three dozen regional navies. In May 2010, the Chairmanship of this grouping was passed on by me to the Commander of the UAE Navy for the period from 2010 to 2012. In the years ahead, I am sure IONS will continue to look at collective and cooperative solutions for issues in Indian Ocean. In addition, under the ASEAN Regional Forum (ARF), the Indian Navy has contributed positively to discussions on maritime security. We have also contributed to regional efforts for safe navigation in the Malacca Strait.

India is seen today as a net security provider. I am certain that you would agree that good order at sea is critical to our national interests. No navy can hope to ensure good order at sea on its own, and therefore cooperative efforts are increasingly becoming the norm. A robust Indian naval presence is in our interest, so that we can make effective contributions to a cooperative regional security order.

The cooperative approach of naval forces to fight piracy off the coast of Somalia is a case in point. The Indian Navy has discharged its responsibilities with distinction and we continue to have a ship on patrol in the Gulf of Aden escorting merchant ships in direct coordination with

Brahmos

the Director General Shipping. To date, over 1,350 merchant ships of varying nationalities have been escorted safely and about a hundred of these have been Indian flagged vessels. At least 22 piracy attempts have been averted by the Indian Navy's ships patrolling the Gulf of Aden. India is engaged with other countries on capacity building and consultations in the area of anti-piracy for keeping access points open and avoid choking of international trade.

I am of the opinion that our men and women are our most valuable assets. The Navy is facing a shortfall in both uniformed and civilian personnel. Civilian personnel form the backbone of our maintenance force and have longstanding expertise, which we can ill afford to lose. We are making all efforts in conducting special recruitment drives to decrease the shortfalls. Shortages of service personnel are also being progressively reduced through additional recruitment.

Let me conclude by stating that the future holds out numerous challenges for the Indian Navy as we step into the next decade. Along with force modernisation and operational capability enhancement, my focus would be towards maintaining a high tempo of operations towards strengthening all aspects of maritime security, as well as building a versatile, networked and capable maritime force that is suited to defend national interests in the future."

Indian Navy Force Requirements and Indigenous Capability

The Chief of Naval Staff, Admiral Nirmal Verma released the *'Study on Building India's Navy: Force Requirements and Indigenous Capability'* during the inaugural session of International Seminar and Exhibition on Naval Armaments, NAVARMS 2010, organised by Confederation of Indian Industry (CII) at Manekshaw Centre, New Delhi on 24 November 2010.

The study identifies the gaps between the capabilities of the Indian ship-building industry and Indian Navy's requirements, and also suggests methods of bridging these gaps. Contrary to the common belief that the Indian industry is incapable of delivering sophisticated systems and equipments, the study has found that the "Indian industry has the capability, competency and capacity to deliver high technology systems, products and modules provided some definitively encouraging measures are undertaken to promote the domestic naval industrial complex".

Some key issues

India is destined to take its place in the emerging global world order as a regional power and global interlocutor. Therefore, enhancing national capacity for new technology ship construction and aircraft/helicopters is imperative.

In 1964, the Indian Navy was authorised a force level of 140 ships and submarines, but, even after four decades, the naval force level hovers (at best) around 130 ships and submarines, but with about 40 percent of the force equipped with vintage weapons, sensors and communications. The Naval Defence Industry is dominated by Public Sector Industries, the sector is now clearly willing and able to establish equivalent or better capabilities at their cost and this should be encouraged. There is a demand of more than 7 ships every year for the Navy and another 5 ships for the Coast Guard. Public Sector Shipyards, going by their previous record, on their own cannot deliver 12 ships per year. According to the CII Study, "Equal opportunity for the private sector is required to achieve the force levels that the Navy seeks. Single vendor bidding and nomination route for awarding Naval projects to Defence Public Sector Units does not lead to real price discovery and should be done away with. Indian Private Sector is poised to take up big naval projects and contribute its share to achieve broader maritime objectives of effective sea power and national goals of peace, prosperity and security."

Issuing the collective requirement of the defence forces, for instance the total number of radars required by all the Services, would present a clear and coherent picture to the industry of the addressable opportunity and provide stimulus to private industry to invest in the Greenfield areas.

"The Buy-and-Make (Indian) categorisation is the best vehicle to promote indigenous naval industry, manufacture and global sourcing but requires final integration in India. The MoD must declare its intent that all future acquisitions would preferably be through the Buy and Make (Indian) Route."

"The Indian Navy and the DGNAI must also share their requirements with Indian industry which CII can facilitate to make all stakeholders on the same page to prepare a capture plan that would truly transform Indian naval industry."

Admiral Nirmal Verma rued that Indian defence imports stood at a staggering 65 percent of the total defence acquisition, which could be reversed only through the active participation of the private sector industries. Compared to Defence Public Sector Undertakings and Ordinance Factories, private sector involvement in defence acquisitions was very low. "There is a need to encourage private sector to promote indigenisation and achieve self-reliance as far as defence requirements are concerned". Considering the abundance of scientific and technical manpower in the country, the CNS said that he was looking forward to seeing leading armament manufacturers of the world setting up armament R&D centres and production bases in India. Before concluding his address, the Naval Chief suggested that the private sector needed to synergise its strengths, compete domestically and globally, and aim at becoming net exporters, and this "was highly achievable."

Based on a CII study.

HAL

A Wake-Up Call !

"Untapped Maritime Wealth of India"

In the first of what promises to be a fruitful series of National Maritime Foundation-sponsored Maritime Awareness Lectures (NMF-MAL), Commander-in-Chief of the Eastern Naval Command, Vice Admiral Anup Singh attempted to reawaken the image of India as a maritime power from many decades, if not centuries, of slumber. Admiral Anup Singh's speech was peppered with Punjabi wit, but that did not diminish its serious message: India's rise as a global power will increasingly depend upon the sea. In introducing Vice Admiral Singh, NMF Chairman and former Chief of Naval Staff Admiral Arun Prakash noted that such a lecture would be unnecessary in the U.S., Britain, or Spain, countries that long ago understood the connection between sea power, economic might, and political influence. As India looks forward to a future as one of the world's top three economies, Admiral Arun Prakash and Vice Admiral Anup Singh suggested a look back to a seafaring past that saw India as the hub of a trading network stretching from Southeast Asia to Western Europe.

Admiral Anup Singh began his lecture by inverting the map of the Indian Ocean and by asking his listeners to similarly turn conventional ideas of India's place in the world upside-down. The Indian Ocean, he pointed out, is not as open as the Atlantic or Pacific, but is rather shaped like a goblet with a wedge in its centre. That wedge is India, to whose shores the routes linking the Western Pacific to the Mediterranean Sea and Persian Gulf adhere closely, almost "as if to pay obeisance". He mused that such a conception would have Winston Churchill - who disparaged the notion of India as a geopolitical unit - turning over in his grave. One imagines Lord Curzon, on the other hand, smiling in approval. Though India has long been governed with continental concerns paramount, Admiral Anup Singh reminded his audience that India's trade and influence primarily radiate seawards, on account of terrain and competitive or hostile neighbours. This observation brought Admiral Prakash's comparison of India to the U.S., Britain, and Spain into focus: India has more in common with maritime, even island, nations than with continental powers.

Yet, India's maritime power remains very much "a work in progress", placing many of the blessings bestowed by her commanding position in the Indian Ocean beyond her reach. As anyone who has read Alfred Thayer Mahan will recognise, maritime power begins with commercial shipping. Admiral Anup Singh painted a striking picture of the "sickness" afflicting India's ports, whose combined annual throughput of 850 million tons barely exceeds Shanghai's! To explain why, Admiral Anup Singh highlighted problems in cargo evacuation, logistics, mechanisation–and red tape. From a shortage of crane loaders and berths for 'Panamax'-size vessels to overstressed transportation infrastructure and onerous customs procedures, Indian ports often keep cargo ships waiting at anchor for days. Privately-developed ports, now 30% of India's total, are beginning to change this picture, with Mundra's 29,000 metric tons per day of cargo throughput embarrassing Mumbai's recent average of about 7,000.

On a more Mahanian note, Admiral Anup Singh pointed out the limited size of India's merchant fleet and subordinate place in the world shipbuilding market. Though Indian firms build highly advanced vessels, they find little domestic demand for them. In the fisheries industry, which Admiral Singh considered exemplary of India's "unorganised sector", most vessels are neither motorised nor mechanised, and less than one percent can operate in waters deeper than 150 meters. This lack of deepwater refrigerated trawlers puts the fertile waters off India's east coast outside the reach of Indian fishing nets. "In the Indian Exclusive Economic Zone (EEZ), most fish die of old age", Admiral Anup Singh quipped. Since the waterborne terror attacks of 26 November 2008, however, most Indian fishing vessels have at least been registered with local authorities.

Vice Admiral Anup Singh proposed the development of new commercial ports and shipyards on India's east coast, blessed as it is by easy access to deep water. He also suggested a far greater utilisation of India's inland waterways and coastal shipping routes over inefficient and crowded roads and railways. Admiral Singh looked primarily to India's private sector to pull off such a dramatic course correction, given the historic and continuing resistance of government ports and their labour unions to mechanisation.

From the discussion that followed, it was clear that the most helpful thing the government could do was to enable the principal stakeholders including local fisher folk and the private sector to enhance their capacity to exploit India's proven maritime potential. NMF founder-Chairman (Retd) Vice Admiral K.K. Nayyar recounted that when he asked a prominent minister whether the 16 ministries and 40 departments of the Indian government that deal with maritime issues could be brought together in a single 'maritime commission', he was told how all the competing jurisdictions made such a commission impossible. What will it take to change the territorial mindset that stands behind such a response? Vice Admiral Anup Singh and Admiral Arun Prakash firmly believe that increasing maritime awareness is the first step toward reversing decades of neglect of the sea, a neglect that continues to hamper India's rise to great-power status.

Hopefully the NMF Maritime Awareness Lecture Series will provide such necessary impetus.

Matthew Myers

In comparison to India, China has made great strides during the last 40 years in shipping. Their shipping capacity is 7 billion tonnes and is growing at 14%. India's total tonnage is only 8.83 million tonnes: it has 646 ships for overseas trade. We can boast of just a few shipyards whereas China has as many as 492; in addition, China has an extensive network of inland waterways. India has several heritage sites waiting to be developed for tourism like the million years old heritage sites at Halong Bay in Vietnam.

The maritime wealth of India can be tapped if only all the stakeholders, Ministries of Defence, External Affairs, Shipping, Home Affairs, Agriculture, Petroleum and Natural Gas, Indian Navy and Coast Guard, Public and Private Shipyards, Oil Companies, State Maritime Boards, among others, join hands and act in unison.

JCM

DSNS, MDL and the P75 Scorpene

Vayu's interaction with Patrick Boissier, Chairman and CEO of DCNS

"The DCNS Group employs 12,000 personnel worldwide and generates annual revenues of around €2.4 billion (previous-year figures). It has undergone a profound transformation, changing in just a few years from a government administration to an efficient and profitable stand-alone company. Still we have an ambitious growth strategy for the years ahead. More specifically, the Group aims to double revenue over the next ten years. To meet this unprecedented growth target, DCNS must increase revenue in many areas. As for naval defence exports, this market segment represents a potential demand exceeding € 3 billion per year. The Group has a wide portfolio of advanced-technology products and services that meet the latest defence and security needs for naval defence. In civil nuclear engineering which is a fast-growing market, DCNS is simultaneously positioning itself as a prime contractor for subassemblies, an equipment manufacturer and a service provider. In ten years time, the Group aims to achieve annual revenue in this segment of €300 to €400 million. Although still at an early stage in marine renewable energy (MRE), this market offers excellent prospects and is expected to expand to several billion Euros per year over the medium term. The first step is to increase R&D investment and contribute to projects to build prototypes and demonstrators".

"After the inauguration of DCNS India in March 2009, meeting the (professional) media again in India was a high priority on my agenda considering the contracts we are involved in, among them the Indian *Scorpene* submarines programme also known as P75. Under the P75 contract, DCNS is in charge of transfer of technology (ToT) to Mazagon Dock Limited (MDL) state-owned shipyard in Mumbai, for the building of 6 Scorpene submarines. We are conducting genuine transfer of technologies and of know-how at an unprecedented level from the first submarine onwards. We are providing our Indian partners with technical assistance to manufacture equipment through indigenisation programmes. Today MDL has absorbed the demanding technologies associated to hull fabrication. The shipyard modernisation programme launched by MDL will allow them to deliver more than one submarine per year. The Indian shipyard is done with the hulls of the first and second submarines. Third and fourth hulls are in progress while the frame to receive the hull of the fifth submarine is under manufacture".

"The outfitting works are now ongoing and delivery of combat system equipment for the first submarine will be completed soon, with the following ones being delivered at the rate of one per year. As a reminder, MDL is the only Indian naval shipyard to have produced submarines in the past. However, the competencies developed have seen a 'breach' for the last 15 years. As you know, the launch of the first submarine has been delayed. We are constantly working with MDL and Indian authorities to achieve the earliest possible date of launch. For the upcoming stages of the building (outfittings together systems integration and running of trials), an adapted organisation from the shipyard is needed. Together with MDL, we have created a common 'task force' aiming at quality and at the greatest efficiency".

DCNS Chairman and CEO Patrick Boissier with Vice Admiral H.S. Malhi, Chairman/MD, of Mazagon Dock Limited.

"The MDL team is highly motivated and we are eager to satisfy the Indian Navy. On P75, India is to acquire industrial self-sufficiency thanks to a comprehensive understanding and mastering of the systems involved. Looking beyond, DCNS will, of course, be on hand to provide these types of services to support other contracts as the group wins in India. The DCNS group's future depends on international development — particularly in India. India is surely aiming at protecting both its territorial integrity and sovereignty. The Indian Navy is evolving and is seeking to acquire high-performance vessels integrating high technologies. These include projection and command vessels, offshore patrol vessels and of course the new P75 submarine programme".

"The Indian and French governments are developing strategic collaborations between both countries. DCNS are willing to make significant contribution through our global experience and expertise to the Indian companies and will be able to add a lot of value through our R&D, technologies, know-how and programme management capabilities. Through local partnership arrangements, such as the one we have with MDL, we can offer the Indian Navy the ability to build vessels in India, based on proven designs and incorporating the full range of DCNS technologies. Local partnerships will also facilitate in-service maintenance and through-life support. These are win-win partnerships for greater heights, where all parties enhance their capabilities. The P75 is of course an important milestone for us globally and we would like to demonstrate our capabilities through successful execution of this programme. We hope to use that as a stepping-stone towards being associated with many more prestigious and large-scale projects in the times to come".

CATOBAR OR STOBAR OR STOVL ?

Building the Indian Navy's

Since 1947, the Indian Navy has, like most medium-sized navies of the world, gradually evolved into a balanced force and is presently attempting a carefully planned transition to blue water capability. This evolutionary path was also followed with regard to aircraft carriers, as also the type of aircraft which operate from them. Navies of the world today operate about 22 aircraft carriers with sizes ranging from a modest 12,000 tonnes (capable of operating a dozen aircraft including 6 to 8 fighters), to 'super carriers' of about 100,000 tonnes (capable of operating about 80 aircraft, including over 40 fighters). The US Navy operates all the ten 'super carriers', extant, while others are beginning to accept that a 65,000 tonne aircraft carrier, capable of operating over 40 aircraft (including 36 fighters), is the optimum size for a medium-sized navy (particularly those of India, UK, France, Russia and China).

There is little doubt that aircraft carriers remain essential instruments of seapower in a balanced Navy, along with submarines and missile-armed warships. These capital ships are required to carry out certain tasks of sea control, neutralisation of enemy fleet units, in support of amphibious operations and destruction of enemy's capability to wage war, attacking hinterland targets (aviation assets, army installations, industrial complexes, transportation infrastructure, and terrorist camps).

'super aircraft carrier'

The Indian Navy acquired its first aircraft carrier in 1961, the 16,000 tonne INS *Vikrant* capable of CATOBAR (Catapult Assisted Take Off, but Arrested Recovery) operations with Sea Hawk jet fighters and Alize anti-submarine warfare (ASW) turboprop aircraft. As the Sea Hawks were phased out in the 1980s, they were replaced by the STOVL (Short Take Off and Vertical Landing) Sea Harriers which operated from a ski ramp on the modified INS *Vikrant,* and thereafter also the newly inducted ex-RN 28,000 tonne INS *Viraat* (also with a ski ramp). The Alize was unable to operate from ski ramps and so were based ashore. They were gradually phased out, with ASW tasks being carried out by Sea Kings and Ka-28 helicopters. Limited Airborne Early Warning (AEW) is provided by the Ka-31 AEW helicopters.

Indian Navy planners would have certainly studied the 32,000 tonne nuclear-powered French aircraft carrier *Charles de Gaulle*, which uses the CATOBAR, embarking about a dozen Rafale fighters, along with four E-2C Hawkeye AEW aircraft and some helicopters. The next generation 65,000 tonne British *Queen Elizabeth*-class carriers (induction into Royal Navy after 2014) will operate about 36 F-35Bs and large helicopters for AEW and ASW-class operations (but there has been a major change from STOVL to CATOBAR – see *Vayu II/2010)*. The first Chinese Navy STOBAR carrier (ex-Russian *Varyag*, re-named '*Shi Lam'*) is a sister ship of the similar Russian aircraft carrier *Admiral Kuznetsov*, and on commencing sea trials by 2015, will operate a "few" fighters (based on the Su-33). China is reportedly building two more STOBAR 50,000 tonne, conventionally-powered carriers. The 100,000 tonne American *Nimitiz*-class nuclear-powered carriers (CATOBAR type) embark some 80 aircraft of various types including over 40 fighters (F-18 Super Hornets or their replacement by 2012, the F-35B, and E-2C/D Hawkeye AEW, plus S-3 Viking ASW aircraft, plus helicopters).

With the original INS *Vikrant* now long decommissioned and INS *Viraat* on its last gills, the IN expects to induct the 44,000 tonne STOBAR INS *Vikramaditya* (ex-*Gorshkov*) in 2012-2013, which will embark MiG-29Ks, the Ka-31s and perhaps the LCA Navy. This 40,000-tonne aircraft carrier can operate a mix of about 26 aircraft (around 18 fighters, and the balance helicopters and/or AEW aircraft in case of CATOBAR). These aircraft will also operate from the 40,000 tonne STOBAR Indigenous Aircraft Carrier (the new INS *Vikrant*) now being constructed at Kochi, which will be launched in 2014, and should become operational a few years thereafter.

The USS George H.W. Bush (CVN-77).

Assuming the 20 year expected life of the INS *Vikramaditya* and the 50 year life of the (new) INS *Vikrant*, plus the endurance cum speed limitations of the Ka-31 AEW helicopter, discussions have begun (as per media reports) for a new carrier borne jet fighter and also a carrier borne AEW aircraft (media reports indicate interest in the American E-2D Hawkeye). There is talk of a new large aircraft carrier of about 65,000 tonnes which could be conventionally or nuclear powered and could be of the STOVL or STOBAR or CATOBAR type.

Let us first study nuclear propulsion, which is critical for submarine stealth, but does not give the same "value addition" to an aircraft carrier. (*Vikramaditya* is steam powered, while *Vikrant* will be gas turbine powered) In addition to being "visible" and detectable by radar, satellites, submarine sonar and passive electronic means, a nuclear-powered carrier would still need almost weekly replenishment of aviation turbine fuel from an accompanying tanker. Also in our scenario, in addition to highly trained nuclear reactor operators and specific dockyard facilities, we would need access to modern technology which would enable Highly Enriched Uranium (HEU) to be safely used in a reactor using very complex technology to ensure safety and an operating life between reactor fuel change of about 25 years (changing reactor fuel in an aircraft carrier's multiple reactors, takes about 3 to 5 years). In my opinion, this will be a major factor in favour of going for a conventionally-powered aircraft carrier.

Finally, the cost. A 65,000 tonne carrier will cost about US $5 billion, while each modern F-35 type of fighter costs about US $150 million at 2010 prices. It is owing to such expensive aircraft costs that the British are considering inducting only one 65,000 tonne carrier and want to sell the second one to India (but hopefully, India will build its own, instead of importing one).

Artists depiction of HMS Queen Elizabeth.

The INS Viraat (R-22) with Sea Harriers embarked.

The Cochin Shipyard is limited by the size of its dry dock and thus can build aircraft carriers of up to 40,000 tonnes only (including the present IAC-1). The only shipyard capable of building over 65,000 tonne aircraft carriers (along with submarines, warships and naval replenishment tankers) is the ultra modern Pipavav Shipyard Limited (PSL), which is located in the southern Gujarat coast, and is larger than all the Indian shipyards combined! PSL already has one massive dry dock of over 680 metres length and 62 metres width and its second dry dock (over 700 m long and 65 m wide) will be the second largest in the world when completed by mid 2012. Logic and commonsense indicate that India should build a conventionally-powered 65,000 tonne carrier at PSL. Indeed, such a move would be in keeping with the November 2010 announcement by the Defence Minister that from January 2011, Defence shipyards "would have to compete with private yards to meet the growing needs of the Indian Navy for submarines and warships."

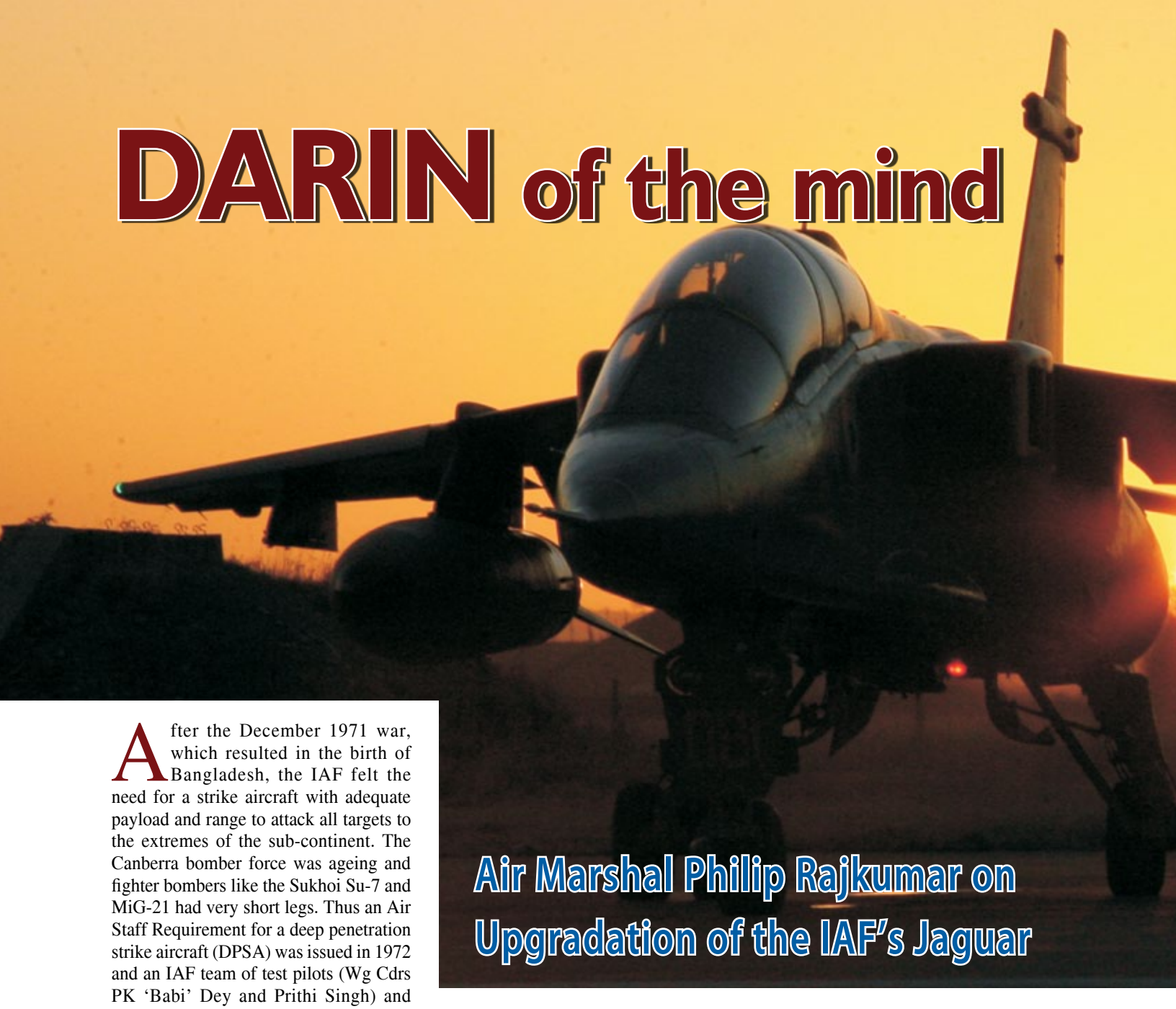
Whether the IN's future aircraft carrier is configured for STOVL or STOBAR or CATOBAR launches, will depend on what kind of future aircraft the IN selects. The present options are limited to

- ⇨ a Ski ramp STOVL type aircraft carrier to operate the fifth generation US F-35 Lightning II which will become operational after 2012. For AEW, this carrier will require a Ka-31 type of helicopter, while ASW helicopters would also be embarked.
- ⇨ a Ski-ramp STOBAR-type aircraft carrier to operate fourth generation jets like the MiG-29K and LCA Navy. Helicopters would be needed for AEW and ASW operations.
- ⇨ a CATOBAR type aircraft carrier to operate the fifth generation US F-35 Lightning (CATOBAR variant, to be operational after 2012), or 4+ generation fighter types like the F-18 Super Hornet or the French Rafale. This carrier could also operate fixed wing aircraft for AEW (eg the Hawkeye 2D) and ASW (eg the Viking S-3), in addition to various types of helicopters. Since such a carrier would take about 8 years to complete, it could even operate a carrier STOBAR or CATOBAR version of the Indo-Russian fifth generation fighter (FGFA or T-50) which is expected to become operational with the IAF in the third decade of the 21st Century.

My personal view is that a 65,000 tonne (CATOBAR or STOBAR) type aircraft carrier should meet our requirements for the next 40 to 50 years, while an equally important decision would be to select the right aircraft mix, since a carrier is essentially designed to operate specific aircraft types.

Vice Admiral (Retd) Arun Kumar Singh.

DARIN of the mind

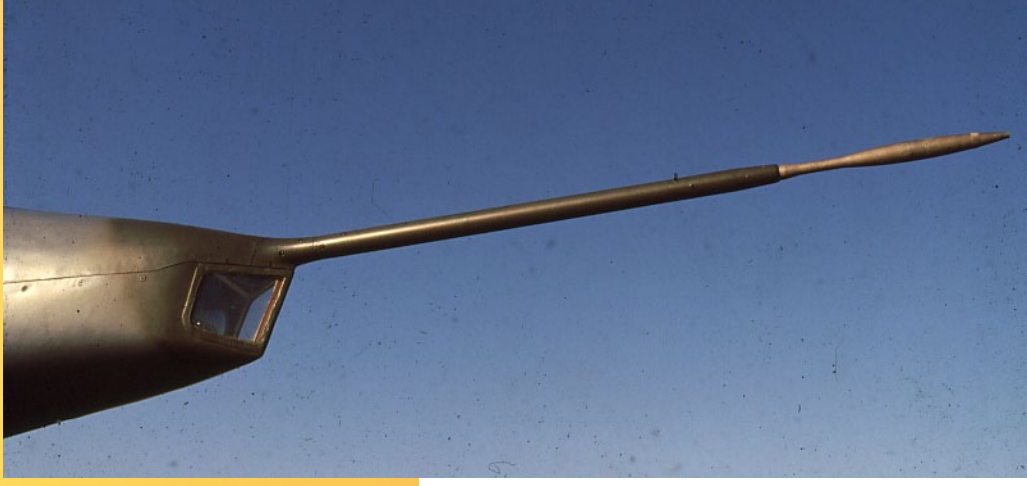


Air Marshal Philip Rajkumar on Upgradation of the IAF's Jaguar

After the December 1971 war, which resulted in the birth of Bangladesh, the IAF felt the need for a strike aircraft with adequate payload and range to attack all targets to the extremes of the sub-continent. The Canberra bomber force was ageing and fighter bombers like the Sukhoi Su-7 and MiG-21 had very short legs. Thus an Air Staff Requirement for a deep penetration strike aircraft (DPSA) was issued in 1972 and an IAF team of test pilots (Wg Cdrs PK 'Babi' Dey and Prithi Singh) and engineers went to France and the UK in May-June 1972. The team evaluated the Mirage F.1 and MirageV in France and the Jaguar and Buccaneer in the UK. The Swedish Viggen was also considered but not evaluated because the USA, still 'cross' with India after its now infamous 'tilt' towards Pakistan in the December 1971 war, refused permission to the Swedes to sell the aircraft as it was powered by an US-origin engine, the J-79.

In May 1974 India conducted a 'peaceful' nuclear test at Pokharan and the major powers immediately imposed a range of technology sanctions. The infamous emergency followed in 1975 and the DPSA fell off the government's radar screen. The Congress party led by Indira Gandhi lost the elections in March 1977. A Janata government led by Morarji Desai finally selected the Anglo-French Jaguar as the IAF's DPSA in the latter half of 1978. The aircraft was equipped with a first generation Inertial Navigation and Attack System (INAS) from Marconi Elliott, called the Navigation and Weapon Aiming Sub System (NAVWASS) which represented a huge improvement in the IAF's capabilities whose pilots would no longer have to depend on the time tested but demanding 'Moving Thumb Display' for navigation. In this method, a line representing the track was drawn on the map with a pencil and the distance, covered at two minute intervals at cruise speed, would be marked along the track. By keeping an eagle eye on the stop watch and moving the thumb along the track, one was roughly aware of one's position on the ground. Formation leaders navigated their way to targets in the 1965 and 1971 wars using this approach! In today's world of GPS-aided navigation this method may sound antediluvian but that is the way it was (with apologies to Walter Cronkite!)

The fundamental principle of inertial navigation is that the double integral of acceleration, with respect to time, gives distance travelled. If acceleration along the direction of flight was measured accurately and the starting point was known, then one could know exactly where one was after a given interval of time. A set of three orthogonal gyros keep the accelerometers



oriented to the inertial frame of reference of true north, true east and the local vertical. A four gimbal topple-free platform isolates the accelerometers and gyros from aircraft manoeuvres. Very accurate altitude information is also available from the gimbal frames for use in flight displays like the Head Up Display (HUD). Inertial platforms have the ability to align themselves to true north by a process called gyro compassing

in which the east gyro measures the earth's rotation (15.041 degrees per hour x cosine latitude) compares it with the earth rate at the latitude of the present position at start up punched in by the pilot and gently keeps rotating the platform till the two rates match. The time taken to do this is called the alignment time, usually about 10 minutes at Indian latitudes.

The contract signed with British Aerospace (now BAE Systems) was for 115 Jaguars. Of these the first 40 aircraft, 35 single seat fighters and 5 dual seat trainers, were to be manufactured at BAe, Warton in the UK. These aircraft would be powered by 2 x Rolls Royce-Turbomeca Adour Mk. 804 engines each delivering a thrust of 5320 pounds dry and 8040 pounds with reheat (sea level static) The remaining 75 aircraft were to be built at HAL, Bangalore and would be powered by Adour Mk.811 engines delivering 5520 pounds dry and 8400 pounds thrust with reheat (sea level static). The Adour 811 engines were to be licence-built at the HAL Engine Division at Bangalore. As it would take time for the aircraft to be delivered from Warton, Her Majesty's Government agreed to loan the IAF 18 Jaguars in service with the RAF for a period of two years. The first batch of these aircraft arrived at Ambala in the second half of 1979 and IAF pilots who had earlier been trained in the UK manned the first Squadron (No.14).

The NAVWASS had a very low Mean Time Between Failure (MTBF) and its navigation and weapon delivery accuracies also left much to be desired. The IAF very wisely decided to fit a second generation INAS in the aircraft which were to be built in India but the question was, which one? Negotiations were held with many foreign vendors and the functionality requirements for the Indian system called the DARIN (Display Attack Ranging Inertial Navigation) were defined. Air Commodore TK 'Tikoo' Sen who was in the Ministry of Defence (MoD) at that time played a very prominent role in defining the system and freezing the specifications. A special organisation under DRDO called the Inertial Integration Organisation (IIO) was set up at HAL, Bangalore with personnel drawn from the IAF, HAL and DRDO. Air Vice Marshal Peter Albuquerque became the first Project Director of IIO in 1980. Group Captain PM Ramachandran (later Air Marshal and VCAS), then Chief Test Pilot (CTP) at ASTE, was posted to the IIO to provide the crucial piloting and flight testing inputs to the project. Wg Cdrs Chandramouli, Vishweshwaran, Bhaskar and Vishweshwariah were some of the technical officers who were deputed from the IAF to the IIO.

The Darin system consisted of three main sub-systems: an Ultra Light Inertial Sub System platform (ULISS-82) made by Sagem of France, a Head Up Display (HUD) made by Smith Industries, UK and a Combined Map and Electronic Display (COMED) made by Ferranti, UK. Some smaller units like the Nav Attack Panel (NAP) which was the main Input-Output device for the system, the Control and Insertion Panel (CIP) on the left horizontal panel into which went the Module for Insertion of Parameters (MIP) which contained mission planning data and the Hand Controller also on the left, behind

the throttles used for changing weapon delivery modes, made up the full system. The HUD computer performed weapon aiming computations in a reversionary mode in case of failure of the main ULISS platform computer. The COMED had a specially prepared moving map of selectable scales on photographic film on which the horizontal situation was electronically displayed. All units of the DARIN system were connected by a MIL-STD 1553B data bus.

In addition to the DARIN system, the IAF decided to install HAL-made avionics in the indigenously-built aircraft. VUC 201 V/UHF radio sets, standby UHF set, HF radio set, ARC 201 radio compass and the RAM-200 radio altimeter were to be fitted instead of the corresponding equipment in the Jaguars made at Warton. All flight instruments in the head down panel were to be instruments made by HAL. All these units would form part of the Standard of Preparation (SOP) of the aircraft to be produced at Bangalore. Along with testing and proving of the DARIN system all these avionic units and flight instruments also had to be tested for satisfactory performance and then cleared.

Frederick Page, Chairman of British Aerospace, came to Bangalore in 1982 and gloomily predicted that the first Jaguar would be delivered to the IAF with holes in the instrument panel instead of a tested and cleared DARIN system! On their part Marconi Elliot officials were very hopeful that an order for at least 20 more NAVWASS would come their way.

Fortunately there were determined and dynamic leaders like Dr VS Arunachalam, Scientific Adviser to Raksha Mantri, Group Captain Baljit Kapur, Chairman HAL, Air Vice Marshal Peter Albuquerque and Group Captain PM Ramachandran who were not daunted by the tight schedule. The enthusiasm at IIO in the early 1980s had to be seen to be believed and all involved did their utmost to achieve the aim of having a cleared DARIN system in the first indigenously produced aircraft.

Two Jaguar fighters, JS102 and JS 103, built at Warton arrived in Bangalore via Ambala in mid-1981 and were immediately set upon by a horde of HAL engineers, technicians and IIO officers who gutted the aircraft of their avionic systems including the NAVWASS. Some structural modifications were carried out

The first Jaguar fighter made at HAL, Bangalore was expected to roll out in mid-1984. IIO, therefore, had the extremely demanding task of integrating the system on two Warton-made Jaguar test aircraft, flight testing it to Initial Operational Clearance (IOC) standard, getting it cleared by the certification agency and then freezing production standard drawings for electrical cabling and hardware installation. It was a very, very tight schedule and grave doubts were expressed by British Aerospace about the outcome of the Indian initiative. Sir

to permit installation of the DARIN Line Replacable Units (LRUs) in the airframe. New electrical looms (cables) were manufactured and installed for the new avionics standard of preparation.

While work was being done on the airframes, integration of the different LRUs of the DARIN system was carried out on the integration rig at IIO. This work included the development of software as required. The integration rig was a static rig which meant that there was no facility to play back a flight after landing and see how symbology on the HUD had behaved in flight. The technology for a dynamic integration rig wherein a mathematical model of the aircraft could be flown using a stick and throttle to assess behaviour of systems in flight had just started making its appearance in the UK, France and the USA in the early 1980s. IIO engineers were somewhat diffident to adopt this new technology owing to lack of experience in using it. The decision to use only a static rig for integration, development and analysis greatly increased the time required to complete the project.

The responsibility for flight testing the DARIN system was given to the Aircraft and Systems Testing Establishment (ASTE) at Bangalore. The Aeronautical Development Establishment (ADE), a DRDO laboratory at Bangalore was made responsible for instrumenting the test aircraft, data reduction and ascertaining accuracies of navigation and bombing sorties. The left hand 30 mm Aden gun was removed from the aircraft and a MARS 2000 multi track magnetic tape recorder installed in the gun bay. The control panel of the tape recorder was mounted at eye level next to the HUD in the cockpit.

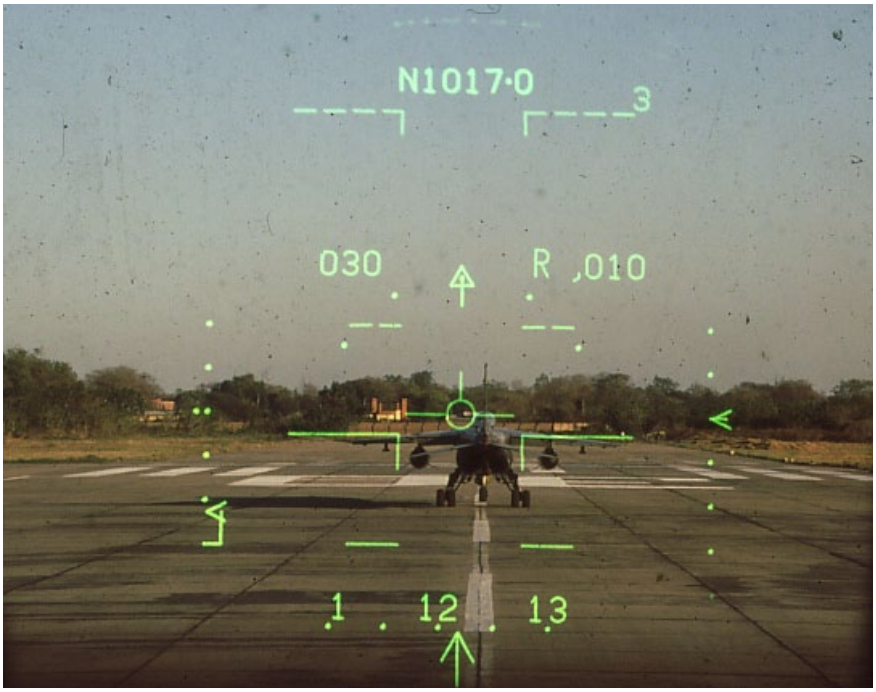
After about 17 months of unremitting effort by the DARIN team, JS102 was ready to fly. The first two sorties were flown by Air Cmde PM Ramachandran, Commandant ASTE, in December 1982. He had taken over command of ASTE from Air Cmde Prithi Singh the previous month. These shake down flights proved that system integration had been done satisfactorily and serious testing to ascertain navigation accuracies of the system could begin. A number of landmarks were chosen in the local flying area and accurately surveyed by the Survey of India. The test methodology was to overfly these check points and obtain fixes using the DARIN system and then determine navigation accuracies.

For bombing sorties with practice and dummy bombs the Sriharikota range, 90 miles north of Chennai and belonging to the Indian Space Research Organisation was chosen. It was only 45 minutes away in a Jaguar. The aircraft had a laser range finder which was not eye safe. SHAR authorities were very concerned about their workers being inadvertently blinded by the laser during low level lay down attacks. They decided that the area which was to be set apart for dummy and practice bomb drops

would be cleared of all personnel and made available for DARIN testing only between 1400 hrs and 1630 hrs from Monday to Friday, excluding public holidays. For live bombing sorties, the Sarmat range at Jamnagar was to be used.

Photogrammetry is a photographic technique by which weapon aiming accuracies can be determined by analysing the HUD camera film recording of a dummy attack. White masonry markers were built around the bombing target to enable accurate measurement of the dive angle and azimuth errors. At SHAR the easterly attack direction meant that the afternoon sun was behind the aircraft and the whitewashed markers stood out clearly in the HUD camera film. This enabled accurate measurement of errors in dive angle and azimuth by assessing the error in milliradians with which the DARIN system had positioned the aiming index on the HUD in relation to the target. Photogrammetry markers were also built around a bombing target at the disused Kolar airfield which was only 40 miles from Bangalore. Kolar was to be used for analysis sorties which did not require bombs to be dropped.

The ASTE had to provide a Range Safety Officer (RSO) whenever the range had to be activated. The RSO would set off from Bangalore in a Chetak helicopter at about 0900 hrs, reach SHAR at 1100 hrs, inspect the area and get ready for the arrival of the test aircraft at 1400 hrs. The Jaguar pilot would have an early lunch and get airborne at 1315 hrs to get there on time. After dropping his load, he would return to ASTE by 1515 hrs. As soon as the Jaguar left the range, the poor RSO had to go to the target area in a bullock cart and measure the miss distances using a calibrated length of coir rope! He then had to get into the Chetak and return to Bangalore 30 minutes before sunset which was the last landing time. As the attack direction took the aircraft over the sea, the Chetak helicopter also doubled as a Search and Rescue (SAR) helicopter. A medical officer from the Institute of Aerospace Medicine (IAM) would go along with the RSO and some essential medical equipment would be kept on board. Tele communications in the 1980s were not what they are today and coordinating a SHAR sortie with different agencies while catering for vagaries of the weather took a lot of effort.



As soon as the test aircraft parked at the dispersal, ADE personnel, IIO engineers and representatives of the foreign companies involved in the project would remove the HUD camera film, take a 'quick look' at the results and then send the magnetic tapes to ADE for detailed data extraction and determination of bombing errors. The results would be analysed by IIO engineers and foreign reps the next day and if all was well the next sortie would be planned.

Sqn Ldr Ajit Agtey (later Gp Capt and now flying A330-300s with Jet Airways) was the project pilot at ASTE and he did extensive flying on the two modified aircraft up to September 1983 to establish navigation performance of the system. In December 1983 he did the first weapon drop at SHAR by dropping 8x25 lbs practice bombs. Sagem engineers at Bangalore hosted a big party at the only five star hotel in the city for all involved in the programme to mark this milestone.

I took over as Chief Test Pilot at ASTE from Group Captain Inderjit Singh Sandhu in September 1984 while still a Wg Cdr and wore my Group Captain tapes a month later. The biggest item on my plate at that time was management of the DARIN flight test programme. The first thing I had to do was to go to Ambala and convert on to the Jaguar which I did by December 1984.

On 6 September 1984, another important milestone was achieved when Sqn Ldr Agtey air tested JS140, the first indigenously-produced Jaguar at Bangalore with the DARIN system fitted on board. The DARIN team had proved the Cassandras wrong! By December 1984, Initial Operational Clearance (IOC) was achieved with 1000 pound free fall and retarded bombs and practice stores. By 31 March 1985 six more aircraft were delivered and No.27 Squadron started to re-equip with these aircraft at Bangalore in the middle of 1985.

I started flying photogrammetry analysis sorties over the Kolar airfield and went to SHAR and Jamnagar later. It was a pleasure to operate the DARIN system as it seemed to behave so much better than the NAVWASS in the Jaguars I had flown at Ambala. Flying a test sortie on the Jaguar was no problem. At a speed of 480 knots indicated air speed (KIAS) at 300 feet above ground level with the DARIN system telling the pilot exactly where he was, low level navigation was now a breeze! In addition, the COMED gave important horizontal situation information like exact position on the ground, track errors, time to go to the next waypoint, present fuel consumption, expected fuel over target and fuel reserve on return to base. The weapon aiming symbology was very pilot friendly and the system made sure the bombs hit the target. What more could one ask for in a strike aircraft!

Keeping the flight test programme on track however, proved considerably more difficult! No.27 Squadron got about eight or nine aircraft and moved out of Bangalore in August 1985. The great enthusiasm seen in all players up to that point in time waned considerably! Keeping Jaguars JS102 and 103 serviceable was a problem because the support base was Ambala which was 2 hrs 30 minutes away in a Jaguar. The ASTE Avro 748 aircraft was always shuttling up and down between Ambala and Bangalore with spares and personnel on board, however now took a long time for Air Head Quarters to set up even minimal technical infrastructure to support Jaguar flying at ASTE.

Two more test pilots who had graduated in December 1983 were inducted into the programme under the watchful eye of Sqn Ldr Agtey. They were Sqn Ldrs 'Nikki' Nerurkar and Ravi Kant Sharma. I was the fourth pilot but spent more time on the ground trying to keep the programme on track! Since there was no dynamic integration rig at IIO to check the effectiveness of a software change it meant another weapon drop sortie with all the coordination problems it entailed. It became a routine of 'fly-fix-fly'.

Bangalore airfield is at an elevation of 3000 feet Above Mean Sea Level (AMSL). During the months of April and May day temperatures go up to 37 degrees Celsius. Jet engines suffer from these hot and high conditions and their thrust drops during take off. Getting airborne from Bangalore with 4x1000 pound bombs + 2x1000 kg drop tanks in an Adour Mk.804-powered aircraft under these conditions required skill, concentration and prayers! One had to wait for 175 KIAS to commence rotation. The nose had to be raised to 16 units angle of attack and held there with a lot of backward pressure on the stick. The wheels had to be retracted as soon as possible after getting airborne at 185 KIAS. When the D-doors opened to allow the wheels to retract the increased drag would make the aircraft stop accelerating and at times even make the speed reduce by a knot or two. The Jaguar had just enough thrust to do the job it was meant for!

By mid-1986 we had cleared the primary bombing modes and it was time to fire 68mm rockets and the 30mm Aden guns. For this phase we had to operate a detachment at Ambala and use the Sidhwan Khas range near Halwara. During

a rocketry sortie, Ajit Agtey picked up a ricochet and the first stage fan module of one of the Adour engines was damaged and had to be replaced. I jumped into the Avro and made a beeline to the office of Gp Capt R Ramamurthy at the Jaguar maintenance directorate at Air Head Quarters to explain my urgent need to complete the trials as planned. We were old friends from the time we were together at Adampur in the late 60s and he was most helpful. He allotted me a spare fan module which had just arrived at Palam from the UK. I collected it, flew back to Ambala where the engines tradesman worked all night changing the module and Ajit was back over the range the next day! Nothing works better than the old boy net in the IAF.

At the end of 1986 Ajit Agtey was posted out to No.27 Squadron. I sent his citation for the award of a Vayu Sena Medal (VM) for the excellent work he had done in the programme. He was awarded a VM in January 1988. I still had the task of clearing the reversionary modes. This work went on all through 1987-88. A fresh Jaguar test pilot Sqn Ldr JP Singh did most of the flying while I struggled with Jaguar serviceability, range co-ordination and focusing on attaining final operational clearance (FOC) for the entire system. When I was beginning to see the light at the end of the tunnel in August 1988 I was posted out on promotion as Air Officer Commanding, Air Force Station, Gorakhpur.

The FOC for the entire DARIN system was finally certified by the Chief Resident Engineer's office in February 1989. Instead of the original estimate of four years and 200 sorties we had taken eight years and 800 sorties to achieve FOC. The IIO remembered my four year long involvement and sent me an invitation to attend the signing and handing over of documents to the IAF at a ceremony at Bangalore in February 1989. Unfortunately I could not get away from Gorakhpur which was a pity.

Whew! What a turbulent and unforgettable ride those four years were for me because apart from the DARIN programme I had to manage more than fifty other service trials during that period.

In spite of the long time taken to attain FOC, the DARIN project was clearly a success story. A lot of system integration experience was gained by IIO, HAL and ASTE. HAL has since on its own been able to integrate the DARIN II system on the old NAVWASS Jaguars. IIO has since metamorphosed into the Software Development Institute (SDI) of the IAF and capability to do software upgrades now exists in house. For the money spent, the benefits were many and long lasting.

Air Marshal (Retd) Philip Rajkumar

Rolls Royce

CELEBRATING

The Icon, Marshal of the Air Force Arjan Singh DFC holds up the painting presented to him of Hurricane fighter in action during the Burma Campaign. He is flanked by Ashok Nayak, Chairman HAL and Dr Nasim Zaidi, Secretary Civil Aviation and Dr CG Krishnadas Nair, President SIATI.

The Centenary of Aviation in India: 1910-2010

Incredible India! There is a distinct contradiction in the Indian psyche. On the one hand, we take pride in claiming that, as narrated in mythology and Indian religious lore, *Pushpak Vimanas* were flying when the rest of the world was still living in caves. Hanuman flew all the way from Sri Lanka to the Himalayas to collect herbs to restore injured Lakshman to health and Rama flew with his entourage to Ayodhya after defeating Ravana in Sri Lanka. And there are other references, too, to our achievements in the field of aviation in ancient times.

But, on the other hand, there seems to be little pride or discernible trace of it amongst the present Indians on us having completed 100 years of heavier-than-air flight in the country. Let alone any official announcement of this epoch marking event– much less any celebrations - on the contrary there were sceptics galore who even questioned the fact that Indians were flying modern day Vimanas 100 years ago! It took a band of zealous and passionate aviation

Pushpindar Singh, President of The Society for Aerospace Studies delivering the welcome address to the gathering at India Habitat Centre, New Delhi.

enthusiasts backed by *The Society for Aerospace Studies* (publishers of the *Vayu Aerospace Review*) to plan and execute a grand celebration of the Centenary which was organised on 2 December 2010 in New Delhi "to create pride in the past and inspire the future". It is hoped that this will initiate a series of commemorative events which should take place in the country through the next 12 months. (see news section *100 Years of Indian Civil Aviation*)

On 2 December 2010, at the India Habitat Centre in New Delhi gathered celebrity aviators at a function which epitomised the Centenary – and not just metaphorically. Led by the icon himself, Marshal of the IAF Arjan Singh who presided, the participants represented celebrated aviators of the Indian Air Force, pioneers of civil aviation, pilots, aviation engineers, designers, managers, doyens of aircraft manufacturing and administrators who made a mark in their distinguished careers. It indeed was galaxy of stars and superstars being awarded 'Oscars of the Air'.

In his welcome address, Pushpindar Singh, President of *The Society for Aerospace Studies*, said that this function was organised in December 2010 to celebrate the epoch-marking events that happened a century ago in 1910. The first powered flights in India actually took place in various parts of the country a hundred years ago. It was just seven years earlier that man had moved into a new dimension with the first heavier than air flight taking place in the USA. Two years later the Wright Brothers demonstrated their early model 'Flyer' in Europe and another adventurous American flew the first aeroplane at Farnborough in England in October 1908. If the recent revelations are correct, one year later, an unnamed Punjabi flew his aircraft in Calcutta in December 1909. In March 1910, the first aeroplane to be designed and built in India flew in Madras, followed by biplanes and monoplanes which were soon flying at Patiala, Allahabad and Secunderabad (also see *Vayu* VI/2010).

Highlighted were the progressive advancement in aviation soon after 1910, the virtually unknown involvement of the Indian Flying Corps which took part in the First World War in the Suez Canal area in 1914; the establishment of Flying Clubs at Delhi, Bombay, Calcutta, Allahabad and Karachi in 1920, the pioneering efforts of the House of Tatas, the UK-India Air Race in 1930 and the establishment of the Indian Air Force in 1932. Twenty years later was the establishment of Indian Naval Aviation, then induction of carrier-borne aircraft by the Navy, formation of an independent Army Aviation Corps and a specialist air wing of the Coast Guard. India's aircraft industry was founded in December 1940 and is exemplified by Hindustan Aeronautics Ltd, now 70 years of age. The spectacular progress of civil aviation industry and the country's space research programme is the jewel in our collective crown.

Marshal of the Indian Air Force Arjan Singh presented the specially designed centenary plaques and ceremonial shawls to select distinguished aviators and aviation professionals, ten of them representing the past ten decades and

Recipients of the 'Centenary Awards', standing behind the panel, holding their plaques (right to left): Air Marshal Satish Lal (on behalf of his father Bhagat B Lal), Capt Saudamini Deshmukh, Anupama Reddy (on behalf of her father-in-law PM Reddy), Reena Kumari (on behalf of her father Maj Gen Dewan M Chand), Air Marshal Denzil Keelor, Air Vice Marshal Ajit S Lamba, HS Khola, Commodore Pran Parasher, Dalip Singh Majithia and nominee from DRDO on behalf of Vivek R Sinha. [Note propellor of Gypsy Moth flown by Dewan Misri Chand in 1936]

'Air Warriors of the future': NCC Air Wing Cadets at the Centenary of Aviation of India event.

one for the 21st century (see Citations). These distinguished men and women recipients were from amongst the innumerable personalities who have flown, navigated, designed, built, maintained and managed aviation assets in India over the past century. Amongst those who spoke and participated in the discussions during the day-long celebration were Dr C G Krishnadas Nair, President, SIATI, Mr Ashok Nayak, Chairman HAL, Air Commodore Jasjit Singh, Director, CAPS, Mr Ajay Prasad, former Secretary Civil Aviation & Defence, Dr A R Upadhya, Director, NAL, Mr Kapil Kaul, India Head CAPA, and Mr Vijay Mathur, former Chairman IAAI.

A future generation of Indian pilots, engineers and other aviation professionals were present in the form of a group of senior students from the Air Force Bal Bharati School and Air Wing of the National Cadet Corps, kitted in their smart uniforms.

The finale of the celebration was a panel discussion on the concept and planning for the *National Air & Space Museum*. This was moderated by the nationally familiar Vishnu Som of NDTV, the participants including Air Marshal Vinod Patney, Air Marshal Ajit Bhavnani, Dr C G Krishnadas Nair, Mr Vijay Mathur, Mr Vijay Seth and Mr Tarun Thakral (see next page).

JCM

Shivani Wazir Pasrich, the compere on the occasion, interviewing the Guest of Honour, Marshal of the Air Force, Arjan Singh, DFC.

The Centenary organisers (left to right) Ajai Kumar, Pushpindar Singh, Vijay Seth.

Promoting the concept of
The National Air & Space Museum

India's aircraft industry, founded in December 1940 at Bangalore, is exemplified by Hindustan Aeronautics Limited, spread over seventeen divisions in various parts of the country, having now produced over 5000 aircraft, both of indigenous design and of licence manufacture. These range from light trainers to new generation combat aircraft while its aerospace division is a world class manufacturing centre for space hardware, including Geostationary Satellite Launch Vehicles. While HAL is regarded as the 'spine' of the aviation industry in India, the National Aerospace Laboratories in Bangalore is involved in advanced technologies and the design of civil training and transport aircraft.


Air Marshal Vinod Patney.

The Indian Civil Aviation Industry has literally grown vertically, with recent years registering an incredible 33 per cent increase in passengers flown. The amalgamated Air India remains the country's official flag carrier and the proliferation of private airlines over the past decade has dramatically expanded air services, a near revolution heralded by new low cost carriers. A major expansion and modernisation of the country's airports will ensure that the aviation sector continues to support the continuous and robust economic growth of the country.

Space activities in the country started during early 1960s using small sounding rockets. Realising the immense potential of space technology for national development, visionary leaders envisioned that this powerful technology could play a meaningful role in national development.

Mr. Tarun Thakral.

Today India's Space Research Programme is one of the most advanced in the world, developing and producing indigenous space launch vehicles and sophisticated satellites.

December 2010 marks the end of the first century of Aviation and Aerospace in India, 100 years of pioneering achievements with many world firsts. This is an opportune time to establish the long cherished National Air & Space Museum to enshrine India's aviation heritage and so inspire future generations.

Proposed Home of the Museum : Old Airport Terminal Building at Safdarjung Airport

Space Requirement : Incorporation of the disused hangars at the northern end of Safdarjung Airport, with specially designed superstructure (impression of flight into the future), and also incorporating the adjoining tarmac area, possibly 5-10 acres of land space.

Display : A variety of aircraft (civil and military) types with ancillary equipment (cockpits, engines etc.). Original artefacts of all types related to aviation, supported with data, neatly presented. Displays would be highly educative and visitor-friendly.

Resources : One time capital expenditure and annual maintenance costs will be calculated based on the final design. The objective should be to make the museum self-sustaining within five years, with generation of revenue from ongoing activities such as aviation conferences and promotion of research with appropriate facilities provided, etc.

Continual Activities : Conference and research projects, technology presentations, aviation scholarships, restaurants and cafes, seminars, workshops and research publications, souvenir shops.

Expertise and Manpower : The Core Team would include special curators, research scholars, maintenance, staff, professional, volunteers and guides.

Preservation & Presentation : Regular upgradation of aircraft displays, related equipment and material.

Sources of Aircraft, Systems & Artefacts : Hindustan Aeronautics Limited, Indian Air Force, Naval Air Arm, Army Aviation, Indian Coast Guard, Indian Space Research Organisation, Flying Clubs of India, Air India, Private Operators, State Government Aviation Departments & Educational Institutes.

Citations

Bhagat B Lal

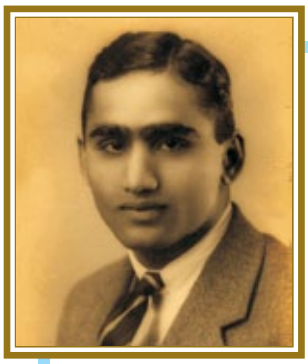
Born in September 1899 at Karnal, Bhagat B Lal graduated from St. Stephens College, Delhi in 1922. He had a great spirit of adventure and a passion to fly from an early age, but was too young to join the RFC in World War I. Thus when the Delhi Flying Club was founded in May 1928, Bhagat B Lal became its first flying member and went on to become a legendary aviator : first Indian to qualify for Pilot's 'A' Licence in March 1929 and also to get the Federation Aeronatique Internationale Certificate (No.5) issued by the Royal Aero Club of India and Burma. His first solo flight was in a Gypsy Moth and he went on to become the first Indian to qualify for the Commercial Pilots 'B' Licence in January 1931 which led to his appointment as Assistant Pilot Instructor at the Delhi Flying Club. He won the Air Race in November 1931 organised to mark opening of the Jodhpur Flying Club and shortly thereafter, led a formation flight of the Delhi Flying Club participating in the Royal Air Force Display in Delhi on 14 November 1931.

Bhagat B Lal was the first Indian pilot sent by the Government of India on a scholarship to the Air Services Training Ltd at Hamble, in England in 1932 (where two decades later the Gnat light fighter was developed). He became the first Indian Chief Instructor of the Delhi Flying Club in December 1933.

During his life Bhagat B Lal played a pioneering role in the development of Civil Aviation, promoting air mindedness and gaining confidence of the Indian Public. Bhagat B Lal retired from the Delhi Flying Club in 1960. During his flying career he had flown over 8600 hours and was later appointed Secretary of the Aero Club of India.

Under his supervision and guidance the Delhi Flying Club trained the largest number of Commercial Pilots, Flying Instructors and Aircraft Engineers who were in time to hold senior positions in the Directorate of Civil Aviation, various Airlines, Flying Clubs and HAL. Some of his pupils included Air Chief Marshal PC Lal (1934), Air Vice Marshal Harjinder Singh (1948-1950). His son, Air Marshal Satish C. Lal, received this honour on behalf of his father.

Pingle Madhusudan Reddy



Pingle Madhusudan Reddy was the doyen amongst pioneers of aviation in India. Born in February 1907 at Warangal in the erstwhile Hyderabad State, he graduated in Mechanical Engineering from Leeds University, UK in 1930, but with a consummate passion for flying, obtained his 'A' Licence in 1931 from Southampton.

PM Reddy participated in the London–Cape Town Air Race with that other legendary flyer, Manmohan Singh and later bought an Avro Avian which he flew back all the way to Hyderabad. In 1935, he attended the Instructors' Course in Navigation at Hamble in England and two years later helped establish the Hyderabad State Aero Club in Begumpet which was later taken over by the Hyderabad State Railway Air Services. During World War II, PM Reddy was involved in the training of scores of IAF cadets at Begumpet.

Later in September 1945, Reddy became Operations Manager, then GM and finally Managing Director of Deccan Airways, one of the best and most efficient airlines of India. He pioneered new routes, organised operations and initially employed foreign pilots while simultaneously training Indian pilots. Because of his diligence and dedication, Deccan Airways became one of the most efficient airlines in the country.

In June 1951, 'PM' was involved with the newly established Night Air Mail Service operated by Deccan Airways Ltd, and soon established a maintenance base for the IAF's No. 1 EFTS at Begumpet. Later, PM Reddy was Regional Director of the Indian Airlines (Bombay Region).

While still as Managing Director of Praga Tools at Hyderabad, he was chosen by the Government to take over as General Manager of HAL at Bangalore. During his tenure there, he was also connected with establishment of the Engine Division which was tasked for producing engines for the Marut and Gnat fighters.

'PM' is remembered for his multi-splendoured career in Indian Aviation and his daughter-in-law Anuradha Reddy, who specially came from Hyderabad, accepted this honour.

Honouring the Pioneers of Indian Aviation

Major General Dewan Misri Chand

Dewan Misri Chand was born in October 1907, studied at the Prince of Wales Royal Indian Miliary College at Dehra Dun and went to the Royal Military College at Sandhurst, receiving his King's Commission in 1927. He joined the famous 1/14 Punjab Regiment ('Sherdils') and saw active service in the Mohmand Campaign in the NWFIP.

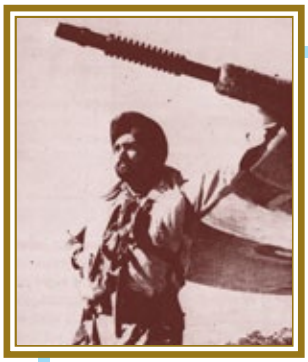
His fascination for flying was soon consummated when he got his flying licence and very quickly proved his prowess by winning the Amateur Flying Trophy in 1933, then holding the trophy for a record 17 years.

His truly was a life lived to the full, as a professional soldier, a passionate aviator, excelling in both areas. In 1934, he participated in the National Air Rally in the USA and in 1936, became the first Indian to win the prestigious Viceroy's Cup Air Race, flying a Gypsy Moth and setting a world speed record. Lord Willingdon personally presented him the Cup. He became the first Indian to compete in the King's Cup Air Race in England and was invited to attend the Olympic Games in Berlin in 1936 where he gave an outstanding aerobatic display.

Post-Independence, Major General Misri Chand went on to command the famous 4th Infantry Division, but continued flying even after his premature retirement in 1953 and became Member of the prestigious Royal Aero Club in England, along with the legendry aviator and industrialist JRD Tata.

He passed away at a fairly young age, in 1970. His daughter Rani Reena Kumari became the youngest Minister (at 26 years was Minister for Energy in the UP Government) accepted this honour for her father. The propeller displayed on the dias, in fact, was lent by her for the occasion is of the Gypsy Moth, that Dewan Misri Chand flew.

Squadron Leader Dalip Singh Majithia



Squadron Leader Dalip Singh Majithia is a quintessential aviator who first made his mark as a fighter pilot flying Hurricanes from Miranshah in the north-west frontier area before moving to the eastern front during the Burma campaign in command of the IAF's No.4 Squadron flying Hurricane IIs.

Owing to exigencies of family business, he left the Royal Indian Air Force in August 1947 and moved to Gorakhpur where the Majithia family had large land holdings. Shortly thereafter, he relocated to Muzaffarpur in northern Bihar where also the first aircraft of the family were acquired, two L-5 light utility aircraft, followed by Beechcraft Bonanza cabin monoplanes. Dalip's passion for aviation was soon to be manifested by the historic feat of landing the very first aircraft, a Beechcraft Bonanza, in the Kathmandu valley.

This pioneering flight into Kathmandu was accomplished with ease and the élan of an experienced and enthusiastic former IAF fighter pilot, with accolades and appreciation coming from the Prime Minister of Nepal who said that, "It was a pleasure to see this afternoon the first aeroplane landing in Kathmandu and I feel that I must congratulate your Excellency for arranging this flight and also Sardar Dalip Singh Majithia for the smooth landing he made over here".

Expressing his "sincere thanks" to Sqn Ldr Dalip Singh Majithia, he added "As a recognition of the services thus rendered to Nepal I should like, to confer upon Sardar Dalip Singh Majithia the decoration of Pradipta Manyabar Nepal Tura". (See *Vayu* III/2010)

Six decades later, Sqn Ldr Dalip Singh Majithia, now ninety-plus, revived for his friends and well-wishers, a chapter of aviation history that has never before been recorded.

Commodore Pran N Parasher

Commodore Pran N Parasher joined the Royal Indian Navy in 1943 in the Executive Branch and became one of the pioneers of Indian Naval aviation. In 1948, Pran Parasher was ADC to Lord Louis Mountbatten who persuaded him to join flying since the acquisition of an aircraft carrier was in the offing. Trained as a fighter pilot in the UK in 1949, he was appointed Commander (Air) of the INS *Vikran*t, Indian Navy's first aircraft carrier in 1962. Pran Parasher (then Lieutenant) had earlier distinguished himself by flying from Lee-on-Solent in England to Malta in a single-seater Sea Fury fighter setting a new speed record in the process.

At the age of 37 Pran Parasher qualified for day and night operations from a carrier deck in an Alize aircraft and served on INS *Vikrant* as Commander (Air) till April 1964.

He was associated with the acquisition of Short Sealand amphibians, the very first aircraft acquired by the Navy and was also at the commissioning of INS *Venduruthy II* at Cochin in 1952. In 1964 he was responsible for transferring the naval unit from Coimbatore to Dabolim in Goa and established the Naval Air Station INAS *Hansa*.

In December 1971, the INS *Vikrant* was at sea in the Bay of Bengal when the war broke out. As recorded for posterity, the briefing by the erstwhile Commander (Air), Cdr Parashar (fondly called by the aircrew as 'The Superman'), was to the point, "Gentlemen this is it". The rest is history.

After retiring from the Navy in 1974, he kept alive his passion for flying and related areas. Now an octogenarian, in his 87th year, Pran Parasher recalls a full and meritorious operational life led as an aviator and his contribution to the establishment and maturity of Naval aviation in India.

Air Marshal Denzil Keelor

'The Keelor Brothers' were to become synonymous with air combat and aerial victories in the September 1965 conflict which electrified the nation with their feats. Both Denzil and his younger brother, Trevor, became fighter aces, shooting down Sabres during that air war.

Air Mashal Denzil Keelor was born in December 1933 at Lucknow, studied at St. George's College Mussoorie and La Martiniere College, Lucknow before joining the Indian Air Force in 1953 where he distinguished himself not only as an exceptional fighter pilot and combat leader but held key Operational and Staff assignments.

Denzil Keelor participated in various operations in Nagaland, Goa and the 1965 and 1971 wars against Pakistan. He was wounded in battle, ejected from his aircraft twice, brought back seriously damaged aircraft thrice. Having survived these air battles, he rose to the rank of an Air Marshal and became the Inspector General, IAF. During the 30-month Indian Peace Keeping keeping in Sri Lanka, he was head of operations at Air Headquarters. The IAF flew over 70,000 sorties there without any loss.

In 1991, he retired from the Indian Air Force but was invited to join the Ministry of Civil Aviation as an Advisor, Air Marshal Keelor set up the Flight Inspection System for the Civil Aviation Industry and was commended for his work by the ICAO. Air Marshal Keelor continues to take active interest in aviation promotional activities and is currently Chairman/Director in several Aviation and Engineering Companies.

At the same time, Air Marshal Keelor is associated with a wide range of social and cultural organisations and is deeply committed to the uplift of people from the backward sections of society. In October 2007, during the World Summer Games in Shanghai, Air Marshal Keelor received the "Award of Excellence", in recognition of his outstanding commitment and unique contribution to the Special Olympics Movement.

Vivek R Sinha

Vivek R Sinha has been one of the most versatile, multi-faceted and talented personalities involved with aviation in the country. He received his MSc degree from the College of Aeronautics at Cranfield, UK, distinguished himself as an Aeronautical Engineer, beginning his illustrious career with the Royal Institute of Technology at Stockholm in Sweden in 1951. His contributions to aviation in India were spread over more than six decades which included involvement in design of the Kiran jet trainer under Dr V M Ghatge in HAL, which has now been in service with the IAF and Navy for over 40 years. As Director, Aeronautical Development Establishment (ADE) in 1970, he initiated the Pilotless Aircraft Project Programme, set up the R&D Simulation Centre, developed aircraft simulators and systems including Head-up Display and rocket pods.

As Secretary of the Aeronautics R&D Board, he was one of those who conceived and planned the Light Combat Aircraft (LCA) project, prepared the pertinent CCPA report and was involved in establishing the Aeronautical Development Agency (ADA) responsible for design and development of the Tejas LCA.

In 1982 he became Chief Controller R&D in the DRDO and coordinated Aeronautics, Materials Development, Life Sciences and Combat Vehicles among other systems, and was appointed as Additional Secretary (R&D) in the Ministry of Defence in 1986.

He also addressed the vital problem of bird strikes to aircraft which was causing numerous fatal accidents to IAF fighters and civil aircraft. He engaged with Dr Salim Ali of the Bombay National History Society to investigate this problem and the ensuing recommendations thereafter resulted in substantial reduction of this hazard to flight.

Vivek Sinha's new 'career' was dramatically different to his six decades in aviation, now being internationally acclaimed as a wildlife authority author and photographer, who has followed the tiger in various parts of India, all documented in his celebrated book *The Tiger is a Gentleman*.

Air Vice Marshal Ajit Singh Lamba

Air Vice Marshal Ajit Singh Lamba was commissioned into the Indian Air Force in April 1955, being awarded the Flying Trophy and Best Pilot of the Year Trophy at the Academy. As he grew in the Service, he shaped into an outstanding and distinguished fighter pilot and was honoured by the President of India with the Vir Chakra for gallantry displayed by him during the Indo-Pak war of 1965. He flew Hunters in action with No. 7 Squadron (which distinguished Squadron of the IAF, known as the 'Battleaxes' celebrated its anniversary on the 2nd December as well).

The Air Vice Marshal's incredible dedication to aviation, first as a fighter pilot, then an experimental test pilot and later with engagement in civil aviation, is evident from his impressive, half a century career, during which he logged over 7000 hours on 90 different types of aircraft, ranging from trisonic fighters to humble sports planes.

Ajit Lamba did his experimental test flying course in Farnborough, England in 1966 and later had the distinction of three tenures at the IAF'S A&ATU, later Aircraft & Systems Testing Establishment (ASTE), the unique establishment of the IAF, from where he retired as Commandant in April 1991. Earlier, he had commanded a Gnat light fighter Squadron and served as Director & Plans at Air Headquarters.

In 1997, Ajit Lamba made the celebrated 'Freedom Flight' in a Pushpak light aircraft from Kanyakumari to Srinagar and back to mark the Golden Jubilee of India's independence.

He remains a consummate aviator, even in his 76th year, is the eldest in the country to hold a valid flying licence. Ajit Lamba carries on flying, giving air experience to students from the Indian Institute of Science, Scientists of the DRDO and ADA but most humanely, to physically impaired children.

H S Khola

One of the greatest revolutions in Indian civil air transportation took place in the 1990s. Mr H S Khola was Director General of Civil Aviation during that epoch decade when the 'open skies' policy was being implemented, which then ushered in the remarkable revolution in Indian air transportation.

Born in March 1942, H S Khola entered the field of civil aviation after acquiring high academic degrees : BSc Engineering Hons (Aeronautics) and MSc (Engineering) from the UK, and reached the apex of his 40 year professional career in aviation as Director General Civil Aviation in April 1993. He served with distinction in that capacity for nine years, till March 2002.

He strode as a colossus amongst civil aviation professionals in Indian country and his extraordinary contribution in this field has been acknowledged not only in India, but also internationally. He most creditably handled a large number of international assignments, as head of multinational ICAO teams, as Project Director and Airworthiness Expert, Advisor on High Tech Systems in the USA and on Air Traffic Control at Australia.

Another landmark in his long career was his assistance to the Naresh Chandra Committee appointed by the Ministry of Civil Aviation to prepare a Road Map for Civil Aviation Development in India.

Mr. Khola's immense expertise in the field of Airworthiness led to his conducting the safety assessment of Afghanistan Civil Aviation for the ICAO. He was elected President of the ICAO Assembly Session in 1998, was Chairman of the Technical Commission of ICAO Assembly Session in 1995 and Chairman of the Asian Pacific Air Navigation Planning and Implementation Regional Group from 1998 to 2002, which took a number of important decisions to enhance safety of air operations in the Asia-Pacific Region.

H S Khola is recipient of the 'National Aeronautical Prize' in recognition of his outstanding undamental and applied work in Aeronautical Sciences and Technology.

Captain Saudamini Deshmukh

In searching for a role model for women in India to join and excel in generally male-dominated high-tech professions, one can hardly have a finer choice than Captain Saudamini Deshmukh who took up civil flying as a profession in September 1980 with Indian Airlines and, having flown over 18,000 hours, retired after 30 years of service in March 2010.

As an Indian Airlines pilot, she flew Fokker Friendships, Boeing 737s and A320s in progressive phases of her career. Even more fascinating are the number of 'firsts' that Captain Deshmukh garnered in her career : the *first* woman in Asia to be check pilot on the Friendship, the *first* Indian woman to captain the Boeing 737 in July 1988; captain of the *first* all-Women Crew flight on a Boeing 737 on 16 September 1989; the *first* woman in Asia to fly the A320 on 24 May 1994; Captain of the *first* All-Women Crew flight of an Airbus A320 in Asia (and probably in the entire world) on 9 June 1995.

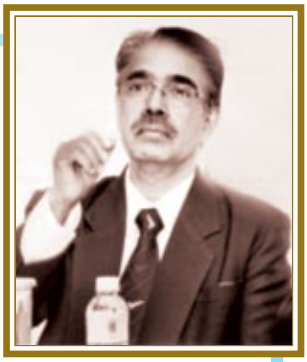
Earlier, in 29 November 1985, Saudamini Deshmukh had captained the *first* ever All-Women crew flight on the Fokker Friendship, the *first* ever on any aircraft flown by any airline in the world.

Besides flying, Captain Saudamini acquitted herself creditably in civil aviation management. From 29 August 1994 onwards, she was Deputy General Manager, General Manager (the *first* woman in the Operations Department) and Executive Director, Western Region for Indian Airlines.

Captain Saudamini Deshmukh has been honoured with several awards: an Achievement Award from the 'Ninety-Nines Inc' (an International Organisation of Women Pilots) in 1977, Certificate of Appreciation from the 'Ninety-Nines Inc' in 1988; the Forest of Friendship Award (Plaque and Certificate) and the F.I.E. Foundation Award in 1991.

The Indian Air Force and aviation wings of other Defence Services have progressively opened their portals to women in the transport and helicopter streams but it was Captain Saudamini Deshmukh who blazed the trail!

Dr. C G Krishnadas Nair



Last, but absolutely not the least, the Centennial Award was given to someone seated on the dias that day, whose extraordinary talents and chequered career in aviation leaves one reeling! Dr. C G Krishnadas Nair, with a PhD from University of Sask, Canada, is an eminent and internationally acclaimed technocrat in the field of aerospace, with significant contributions to the industry and management at the highest level.

Dr. CG Krishnadas Nair was the first professional engineer to become Chairman of Hindustan Aeronautics Ltd, transforming this national strategic entity into a globally competent aerospace industry through long-term strategic plans with strong R&D overtones, diversification of programmes, exports, academic interaction and work culture based on ethics and team work. This resulted in a ten fold increase in turnover and substantial profits.

Dr Nair led the design and development of the Advanced Light Helicopter, the Intermediate Jet Trainer and Light Armed Helicopter, and initiated design of the High Altitude Helicopter, the Multi Role Transport Aircraft and other advanced aerospace projects.

Dr Nair founded the Society of Indian Aerospace Technologies & Industries (SIATI) which stimulated small, medium and large private sector industries to indigenously develop aerospace equipment. This fillip contributed to the growth of private sector participation in aerospace and has pioneered setting up of several joint venture companies for materials and equipment.

Dr Krishnadas Nair later served as Vice-Chancellor of MATS University and was Chairman/Member Governing Council of a number of engineering colleges and became visiting professor at distinguished colleges including the IIT, Chennai. Since May 2008, he has been CEO and Managing Director of India's first international airport at Cochin (CIAL) which has developed into a world-class airport with three - fold increase in its revenue and profit. CIAL has emerged as a model non-metro airport in India and has established an Airport Academy at CIAL which is unique in India. Dr Nair still finds time and has authored 21 books in the field of engineering, technology and management.

For his distinguished service and achievements, he was honoured with the Padma Shri.

Marshal of the Air Force Arjan Singh honouring the pioneers of Aviation in India, amongst them (top to down) Air Marshal Denzil Keelor, Reena Kumari, Capt. Saudamini Deshmukh, Dalip Singh Majithia.

Energising Indian Aerospace Industry "Achievements & Future Strategies"

This was the 5th International Conference on *Energising Aerospace Industry*, jointly organised by the Confederation of Indian Industries (CII) and Centre for Air Power Studies (CAPS) held at the DRDO Bhawan in New Delhi on 15-16 December 2010. *Vayu Aerospace Review* hosted the evening networking cocktails and dinner at the India International Centre. The conference, attended by delegates from abroad, representatives of international and Indian aviation companies, senior officers from the Indian Air Force, research scholars from CAPS, plus special invitees, was inaugurated by Mr AK Antony, Minister of Defence, while Air Chief Marshal PV Naik, Chief of the Air Staff, delivered the keynote address.

Defence Minister Antony stressed importance of such conferences and hoped that deliberations would further strengthen the public–private sector partnership, essential for a sound industrial base, indigenisation and self-reliance in production of equipment and systems for the Defence Forces of the country. He referred to several initiatives being taken to "energise" the Indian defence industrial base, particularly the aerospace sector and mentioned the forthcoming Fifth Generation Fighter Aircraft (FGFA), the Multi Role Transport Aircraft (MRTA), Unmanned Combat Aerial Vehicle (UCAV) and Indian Multi Role Helicopter (IMRH) to be co-developed by HAL with various partners.

"Modernisation of our Armed Forces remains the top priority for us. However, despite our best intentions and earmarking huge budgets and allocating money, the modernisation efforts have not borne the desired results. We must continuously reduce and even eliminate

procedural delays and bottlenecks in our procurement procedures. It is with this realisation that we have put in place a Defence Procurement Procedure that is amended every year to speed up procurement and bring in fairness and transparency to the system. The discussions on the issue of Offsets, in particular, would be of great interest and relevance. While we are willing to learn from international experience, such deliberations also give us an opportunity to remove some undesired and needless misgivings on the issue" (see report on DPP 2011).

Continuing his address, Mr Antony said that "the latest trends in the aerospace sector clearly show that airpower has emerged as one of the most effective resources in enhancing defence preparedness and security of any nation. Air power increases our response capabilities and flexibility. By its very nature, aerospace power continues to be technology-driven. It is for this reason that enhancement of air power capabilities often come at high costs. Developing nations such as India need to link up our unique security concerns with modernisation that does not divorce us from the ground realities. Though we do appreciate the need for partnerships and Joint Ventures at an international level, in the final analysis, each nation cannot do without strengthening indigenous capabilities".

"The rapid development in material technology means that the onus lies on organisations such as the DRDO to devote more and more time, energy and resources to strengthen R&D efforts. These changes must be introduced in a phased, yet time-bound manner to provide state-of-the-art equipment to our military aviators and air warriors."

In his keynote address, Air Chief Marshal PV Naik said that no country could be recognised as a reckonable power by being permanently "at the mercy" of imported arms and equipment to meet its aspirations and agenda. "Our progress in technological prowess is not in consonance with our objective of achieving overall self-reliance. The concerned agencies must understand the criticality of self-reliance in aerospace industry." Air Chief Marshal Naik urged that through appropriate policies the government should create conducive environment for the private sector to absorb critical technologies to achieve the objective of self-reliance. "The indigenously–developed Light Combat Aircraft (LCA) would be inducted by the IAF by mid-2011".

In his address Air Commodore Jasjit Singh, Director CAPS reviewed genesis of the aircraft industry in the country which had begun in the pre-Independence years and that, too, in the private sector. HAL has now been producing aircraft for 70 years, but it is interesting to recall that the Tatas had set up an aircraft factory at Poona in 1942 for licence production of the Mosquito fighter bomber. In the event, however, production remained dormant as the war in the East ended. In the present context, he hoped that the offsets policy would promote R&D and future aircraft would not only be built in India, but also designed in India. Importantly, the criteria for 'offsets' should be based on realities.

Amongst those who spoke in subsequent Sessions were Air Chief Marshal Sir Glenn Torpy, former CAS, Royal Air Force, who spoke on *Aerospace Power: Transformational Trends*, followed by Air Vice Marshal M Matheswaran, Assistant Chief of Air Staff Operations (Space) on *Future Trajectory of Aerospace Power*, Dr Vivek Lall, Vice President and Country Head India Boeing, on *Post Recession Growth and Opportunities – Global Perspective*, Dr V Siddartha, on *Military and Dual Use Technologies: Current Realities.*

In the next Session, Pavan Kaula, Managing Director, Zephyr, spoke on *Challenges in Indigenous Development of UAVs*, and was followed by Commodore Sujeet Samaddar, Vice President, Nova Integrated Systems Limited, on *Civil and Commercial Applications of UAVs: Issues and Challenges*, Mr Jacques Chemla, Business development Director, IAI/MALAT, Israel, on *UAVs: The Experience of Other Countries*, Wg Cdr S K Sabesan, Jt Director Operations (Air Traffic Services), IAF, on *UAVs/ UCAVs: Regulatory and Airspace Issues*, Mr Richard Williams, Project Director Future Capabilities, BAE Systems, UK, on *Future Unmanned System Capabilities.*

On 16 December, during Session III, Andreas von der Heide, Senior Vice President & GM, Industrial Cooperation, Saab AB, Sweden, spoke on *MROs: The International Experience and Lessons,* and he was followed by the familiar (to Indian audiences) Erwin Obermeier, Senior Adviser Exports and Special Projects, EADS MAS, on *Joint Ventures and MROs: Foreign Perspective.* The address by Andre Hiebeler, CEO of Grob Aircraft AG, Germany, of *Joint Ventures and MROs* was prefaced by his out-of-the-box style, commending "Incredible India" for its technological potential but one that "has remained dormant in terms of creating world-class aircraft and exporting them competitively to a waiting world". He was applauded for his free and frank views on the present system. Mr R Shankar, Executive Vice President, RAMCO Industries, spoke on *MROs: A Future Roadmap*.

The afternoon programme, after lunch, is always faced with a diminishing audience but, chaired by Vijay Mathur, this was perhaps the most critical of Sessions, being on 'Offsets'. Air Marshal NV Tyagi, Deputy Chief of Air Staff, IAF was lucid on his treatise on *Defence Offsets: Principles and Prospects.* He was followed by Roger Rose, Chief Executive, Lockheed Martin India and Commodore Prem Chand, Chief Strategist, Tech Mahindra, on *Offsets: Indian Industry Perspective.*

The Valedictory Session was chaired by Air Commodore Jasjit Singh while Ashok Nayak, Chairman Hindustan Aeronautics Limited gave the keynote address, followed by Air Marshal P K Barbora, the outgoing Vice Chief of Air Staff. The end of the Seminar was preceded by Air Vice Marshal Kapil Kak's closing remarks and the vote of thanks by Gurpal Singh DDG Confederation of Indian Industry.

Till next time!

JCM

Are we missing out on something?
Conferences, Seminars, Think Tanks, et al

They occur like flowers, seasonal, unseasonal, beckoning the faithful to come and partake of the intellectual fare that is being doled out on topical issues of national and international import. Big names in industry lend some colour and international participation ensures a sumptuous lunch, not necessarily contributive to an attentive audience thereafter. But these do their bit to attract the intellectual glitterati. These are the conferences and seminars, promoted by well meaning organisations and sometimes, initiated think tanks.

I do not, thankfully, live in New Delhi, but have attended my fair share of these conferences/ seminars, at least as many as my weak constitutional patience permits me to stomach. I must, in all fairness, confess that some of the papers presented/topics discussed have put another brick in the wall of my modest education, but more often than not, I leave the hall somehow feeling hollow, despite the revelry of meeting old pals and joining in, mostly unfinished discussions during the coffee breaks, that threaten to change the course of world history. I have often wondered why the business discussed during the seminars lies buried with the pieces of stationery and other discarded brochures that litter the hall after the more discerning have safely packed their give-away bags with the writing pad and ball-point pen. That makes these gatherings a farce and a colossal waste of time. This is a pretty strong statement coming from an intellectual nobody like me. But, sir, I am the *aam admi*, and if you cannot get through to me then there is a gap in your mission accomplishment. There are a number of reasons that ensure that the gems of knowledge spewed during these seminars/conferences never leave the hall.

Choice of the VIP for the inauguration is often incongruent with the theme and more importantly is restricted to ceremonial purposes, with scant thought to his contribution either during his address or through a follow-up, which leaves a gaping chasm between what is said and what is done. One recent event comes to mind, where an honorable Minister inaugurated a seminar of national significance. He was escorted in by a zealous mob of dignitaries, all parrying for his attention and followed by an equally impressive retinue of officials, all making a bee line for the front row where only intellectual gods are seated. After the Opening Ceremony, customised by chorusing the virtues of the Chief Guest and extolling the plebeians to heed the words of wisdom, so generously sprinkled by him, this body of glitterati disappeared faster than snow in the Sahara, never to be seen again. The thoughts, ideas and recommendations put forward by the eminent speakers and their equally vocal moderators, were left in suspended animation, since those required to implement these schemes were both physically and mentally, light years away from the scene. The Confederation of Indian Industries (CII) who hosted this seminar and the Ministries of Defence (Production), Civil Aviation, HAL and other bodies that could carry a message/implement some very relevant recommendations, were conspicuous by their absence. So while every one present was in unanimity at the dismal state of affairs, there was nobody available to take this to a logical end. Does the onus of ensuring that the nation benefits from the collective wisdom not lie with the organisers, the relevant ministries and public bodies that can add value? The names mentioned are not meant to single out these particular organisations, but are merely illustrative. All others are equally callous.

The attendees also left, most were euphoric about the success of the seminar, while some uninitiated souls, like myself, could not comprehend how we could measure any degree of success of this seminar. Despite some very refreshing ideas, no one was going to implement a word of what was said. Did it not cry out for follow-up action…. but who was going to do that? As far as I know, no one. Wastage through callousness has become an inherent part of our national psyche. But when we start wasting our cerebral capability developed through eons of application, it is a cause to sit up and pause. How many regular or occasional attendees of the plethora of seminars/conferences held, can place a hand on their hearts and declare that these have added value to our national growth through implementation ideas/views exchanged? Yet these seminars, conferences, et al continue, with broad coverage by the media and photo shoots to educate the *aam admi* as to how serious the Masters of this nation are about the future and how our think tanks are burning the proverbial midnight oil, to find the right answers. Slow as I am how come I do not understand….am I missing out on something?!

Air Commodore (R) Parvez Khokar

Grob

IAF's pride:

the Indo-Russian Sukhoi Su-30 MKI programme

During the decade marked by the years 1998-2007, the Governments of Russia and India signed a number of epoch-marking contracts on the Sukhoi Su-30MKI multi-role fighter, with initial deliveries from the Russian factory moving towards increased phase-wise production under license by Hindustan Aeronautics Limited at its Nasik Division.

The Su-30MKI fighters and their technical systems which are now being manufactured in India under license, have their origin in Irkutsk-city, in southern Siberia at the aviation Plant of the IRKUT Corporation which has been in charge of the Su-30 MKI Project from the very start. The total number of these fighters, both supplied from Russia and manufactured in India, will eventually reach 272 aircraft of which over one hundred are already in operational service with the Indian Air Force.

The President of IRKUT Corporation Mr. Oleg Demchenko said to *Vayu* that "the Su-30MKI Project opened a new phase in the aviation area of Indo-Russian strategic partnership. We have shifted from direct supplies and license assembling towards real cooperation. It should be noted that thanks to this Project and marketing efforts of RosOboronExport and FSVTS Agency, a wide market for Su-30 two-seater aircraft has come about and there are now increasing number of countries opting for the Su-30MKI type".

'Creation' of the Su-30MKI multi-role fighter has indeed been a remarkable event in the history of military cooperation between India and Russia. As a consequence of this programme, the two countries which have had a defence-supply relationship since the 1960s, has been transformed from the 'Customer-Supplier' mode of interaction towards joint research, design, development and manufacturing of aviation systems.

The Su-30 MKI has evolved into one of the world's most potent combat aircraft, achieved through such characteristics as super-manoeuverability, state-of-the art avionics, laser-optical locator system with the helmet mounted sighting system integrated with phased array radar and other modern systems.

As required by the Indian Air Force, a number of Indian companies, as well as those from France, Great Britain and Israel have been involved in integration of their systems. Flight information is on four LCD displays which include one for piloting and navigation, a tactical situation indicator and two for display systems information including operating modes and overall operation status. The rear cockpit is fitted with a larger monochromatic screen display for air-to-surface missile guidance. The Su-30MKI on-board health and usage monitoring system (HUMS) monitors almost every aircraft system and sub-system including the avionics sub-systems. It can also act as an engineering data recorder

Beginning in 2010, the HUD and Multi-Function Displays (MFD) are being provided by the Ghaziabad-based Samtel Display Systems. The aircraft is fitted with a satellite navigation system and includes the high accuracy SAGEM Sigma-95 integrated global positioning system and ring laser gyroscope inertial navigation system.

A matter of pride for the IAF

It is now possible to review preliminary results of Su-30MKI in operation with the Indian Air Force as there have been several joint exercises with a number of foreign Air Forces which confirmed the outstanding technical and combat performances of this aircraft.

During the *Cope India 2004* joint Indo-US exercises, Su-30K fighters were ranged against F-15Cs. According to Indian and American sources, in the main part of aerial combat, Indian pilots emerged as winners. Later too, the IAF's Su-30MKI fighters won all aerial engagements with F-16s of the Singapore AF. The same results were apparent in the Su-30MKI against Mirage 2000s during the *Garuda-2* joint French-Indian exercises in June 2006, and against Tornado fighters of the Royal Air Force during exercise *Indradhanush* in October 2006.

Such results of these exercises created a great deal of interest worldwide and a number of Western countries have specially requested the IAF to delegate its Su-30MKI fighters to participate in joint bilateral and multi-lateral exercises.

In August 2008 the IAF's Su-30MKIs participated for the first time in *Red Flag* exercises in the USA, considered as the most realistic military training exercises involving tactical combat aircraft in the world. Besides the Su-30MKI, four Rafale fighters of the French AF, six F-15Ks of the RoKAF, as well as F-15 and F-16 fighters of the USAF participated in the exercises. As the American media reported, the IAF's Su-30MKI made "the most prominent impression" on the exercise participants, specially on those who had an opportunity to fly in the second seat of this fighter.

In November 2008, *Flight International* magazine made an Internet poll on 'the best fighter type worldwide'. The Su-30MKI, F-22 and F-15 were on

Irkut

the short list. 59% of votes were in favour of the Russian aircraft, while the F-22 got 22% and F-15 only 4%.

The Su-30MKI has a special place in India and it is enough to say that two Indian Presidents (Dr. Abdul Kalam in 2006 and Ms. Pratibha Patil in 2009) had opted for the Su-30MKI, when deciding to make a flight of one of the IAF's fighters. The option in favour of the MKI is understandable since the fighter has become the subject of national pride. Every year, the Su-30MKI participates at the Republic Day Parade in New Delhi and at the *Aero India Show* at Bangalore. The Su-30MKI is depicted on the IAF's 75th Jubilee commemorative coin.

Malaysia and Algeria

The success story of Su-30MKI in India has contributed to the decision by Malaysia and Algeria to select an version of the Su-30MK type for their national Air Forces.

The Su-30MKM contract for Malaysia was signed in August 2003, which was completed in 2009. The Su-30MKM is actually a modified Su-30MKI. Its development was carried out by Sukhoi DB in cooperation with other Russian and foreign industries. The Su-30MKM's on-board equipment and armament systems had been improved as per the Malaysian AF's special requirements.

The Su-30MKI(A) delivery contract with Algeria was signed in March 2006, and was also completed in 2009. The Su-30MKI(A) incorporates the Su-30MKI's modifications as well. In 2010, the Algerian Government, being highly satisfied with its Su-30MKI(A) acquisition has ordered from Russia an additional batch of Su-30MKI(A). It must be noted that some on-board radio-electronic equipment of the Su-30MK, supplied by IRKUT Corp to Malaysia and Algeria, includes components of Indian and French origin. There are certain other countries presently considering the procurement of Su-30MKs.

Perspectives for the future

Aviation experts believe in the long-term future of the Su-30MKI and at present, Russian and Indian specialists are working on further development of the Su-30MKI's performance.

This project is understandably complex and expensive. According to certain sources, the Government of India is considering an allocation of US$ 2.4 billion for modernisation of the IAF's present Su-30MKIs, which will be in collaboration with the IRKUT Corporation and the project executed in phased manner starting from 2012. It is believed that such modernisation will be performed at the HAL Nasik Division.

In improving various characteristics of the Su-30MKI, as operational with the IAF, 'deep modernisation' is on the agenda with Russian and Indian specialists are engaged in discussing technical performances of the future 'Super-30', equipped with phased array radar and new weapons, of Russian or other origin.

Importantly, there is ongoing work, in cooperation, with Indian partners, for integration of the BrahMos supersonic anti-ship missiles with the Su-30MKI which may lead towards new market opportunities for both the Su-30MKI and the Indo-Russian BrahMos missile.

The BrahMos land-based and ship-borne missiles are currently being delivered to the Indian Armed Forces. The prototype of the air-borne missile version has been already developed and has gone through a cycle of land-based tests. After necessary modifications, air-launched tests will be carried out.

In November 2010 the IAF provided two Su-30MKI fighters for such modifications and trials with the BrahMos missile. According to Mr. Pravin Pathak, Marketing Director of the BrahMos Indo-Russian JV: "A contract with the Sukhoi DB on the Su-30MKI's transformation into an aerial platform for BrahMos missiles is expected to be signed shortly. Up-gradation of the first two aircraft will be carried out by the IRKUT Corporation."

Test launches of BrahMos missiles from Su-30MKIs will be carried out at the IAF's test ranges with participation of Russian and Indian personnel and it is likely that work will begin on integrating the first Su-30MKI with BrahMos missiles in early 2011, while the test launches are expected to be carried out in 2012.

The BrahMos cruise missile is designed for destruction for a wide range of targets. Its characteristics include long range (up to 290 km), supersonic speed (M=2.8), formidable ordnance load (upto 250 kg), and particular effectiveness against ground radars. The 'shoot-and-forget' principle is well achieved as the missile finds its target autonomously.

The airborne version will be 500 kg lighter than the basic version and experts believe that the BrahMos is incomparable in terms of its supersonic speed and flight range. As compared with its foreign counterparts, the BrahMos has three times advantage in speed, and 2.5 times advantage in range and 3.5 times advantage in reaction time.

Professionals believe that the integration of BrahMos airborne missiles with the Su-30MKI aircraft will significantly enhance the Su-30MKI's combat versatility and make the type even more attractive in the world market.

Boeing Def

Benefits of tandem rotors

When the first tandem-rotor helicopter lifted off - more than a century ago - it literally gave a huge lift to an innovative concept that continues to deliver outstanding performance, capability and opportunity for military and commercial operators around the world.

Now, tandem rotors support country building requirements, provide disaster relief and humanitarian assistance, perform a wide range of military transport and relief operations and have a proven capability to operate in austere environments where conventional helicopters cannot. The fact is that a number of countries including the United Kingdom, France and even Russia have developed tandem rotor configurations. The most notable of tandem pioneers remains Frank Piasecki. His innovation was demonstrated in a highly successful prototype referred to as the 'Flying Banana' in the mid 1940s, and generated unlimited opportunities for tandem-rotor operators.

By the 1960s, tandem-rotors were performing with distinction around the globe, utilised for lifting and transporting supplies, troops and equipment. Recognising their capability to conduct multimission operations, the tandem rotor helicopter was adopted by more than 15 countries world wide during the 1970s and 1980s gaining distinction for its ability to conduct high altitude operations in harsh environments, with speed and agility. As demand for the concept's unique capabilities grew in the international community, so did the variety of airframe configurations produced to meet the requirements of various nations. As tandem rotor advantages became more apparent, the aircraft gained acceptance as a military asset, where it demonstrated its value every day.

The leading example of a tandem-rotor helicopter is the CH-47F Chinook, produced by The Boeing Company for a growing number of customers worldwide, one which has been used for a wide range of humanitarian, heavy lift, troop transport, resupply and personnel duties. CH-47 Chinooks have been used for humanitarian efforts in virtually all recent natural disaster relief efforts, including the earthquake in Haiti and massive flooding in Pakistan.

What gives tandem rotor helicopters an edge over conventional helicopters?

Perhaps the one factor that sets it apart from the competition is its unique ability to lift heavy payloads without wasting any of its power to maintain a stable platform in the air. Typically, a single-main rotor helicopter loses about 10-15 percent of its power operating the tail rotor to counteract the torque from the main rotor. Without a tail rotor, conventional helicopters would spin out of control. The tandem-rotor design, however, eliminates the need for a tail rotor, thereby allowing 100 percent of its power to be used for lifting, greater operational agility in a wide range of missions, and a wider centre of gravity. Put simply, the tandem rotor design enables operators to carry more, keep lifecycle costs down and perform their missions with greater manoeuvrability than conventional helicopters.

Because of their design, tandem rotor aircraft offer more useful load capability per input horsepower than their single-rotor counterparts in the heavy-lift class. With conventional helicopters, the only way to match tandem rotor payload capability is to build more powerful aircraft that are even larger and more expensive to operate. A tandem rotor system gives operators more capability for a smaller investment, and with budgets being reduced globally, getting the most for an investment is a priority these days.

For the same operational footprint, overall length and width, which defines size of takeoff and landing sites, tandem rotors have 44 percent more total rotor area and lower disc loading. This allows tandem rotor helicopters to use smaller diameter rotors while generating greater lift efficiency and requiring smaller engines. Because of the tandem rotor's design, which uses two sets of main rotors, it is virtually unaffected by cross winds, enabling it to operate in mountainous

The Boeing CH-47F Chinook.

regions as high as 20,000 feet and to operate routinely at 14,000 feet, higher than most conventional rotorcraft. The highest recorded altitude for a rescue operation by a tandem-rotor aircraft is at 16,200 feet. Of course, once a helicopter reaches high-altitude in rugged terrain, the pilot must come to grips with challenging mountainous landings or approaches, altitudes and conditions that often restrict the performance of conventional helicopters. Typically, a single rotor helicopter must handle high winds head-on to maintain control, while the tandem rotor will handle high wind situations from any azimuth, making it ideal in high altitude situations. There are many recorded high mountain rescues performed by these aircraft.

Yet another advantage is the rear ramp of a tandem rotor helicopter which is not restricted by tail rotor clearance, can operate in all types of conditions, allowing it to hover atop a mountain, with only its rear ramp touching the ground as a rescue mission is performed. Another benefit of the tandem rotor design is quicker transit in or out of landing zones due to better low-speed agility / manoeuvrability. Tandem rotorcraft helicopters offer the ability to routinely fly at speeds of 170 mph (one tandem rotor configuration flew at 240 mph), cutting the time needed to deliver their payload. Additionally, because tandem rotor aircraft have the lowest downwash of all large helicopters and can feature triple hooks, their effectiveness has been well documented in a variety of military and humanitarian missions, especially where the safety of victims can be threatened by turning tail rotors of conventional helicopters.

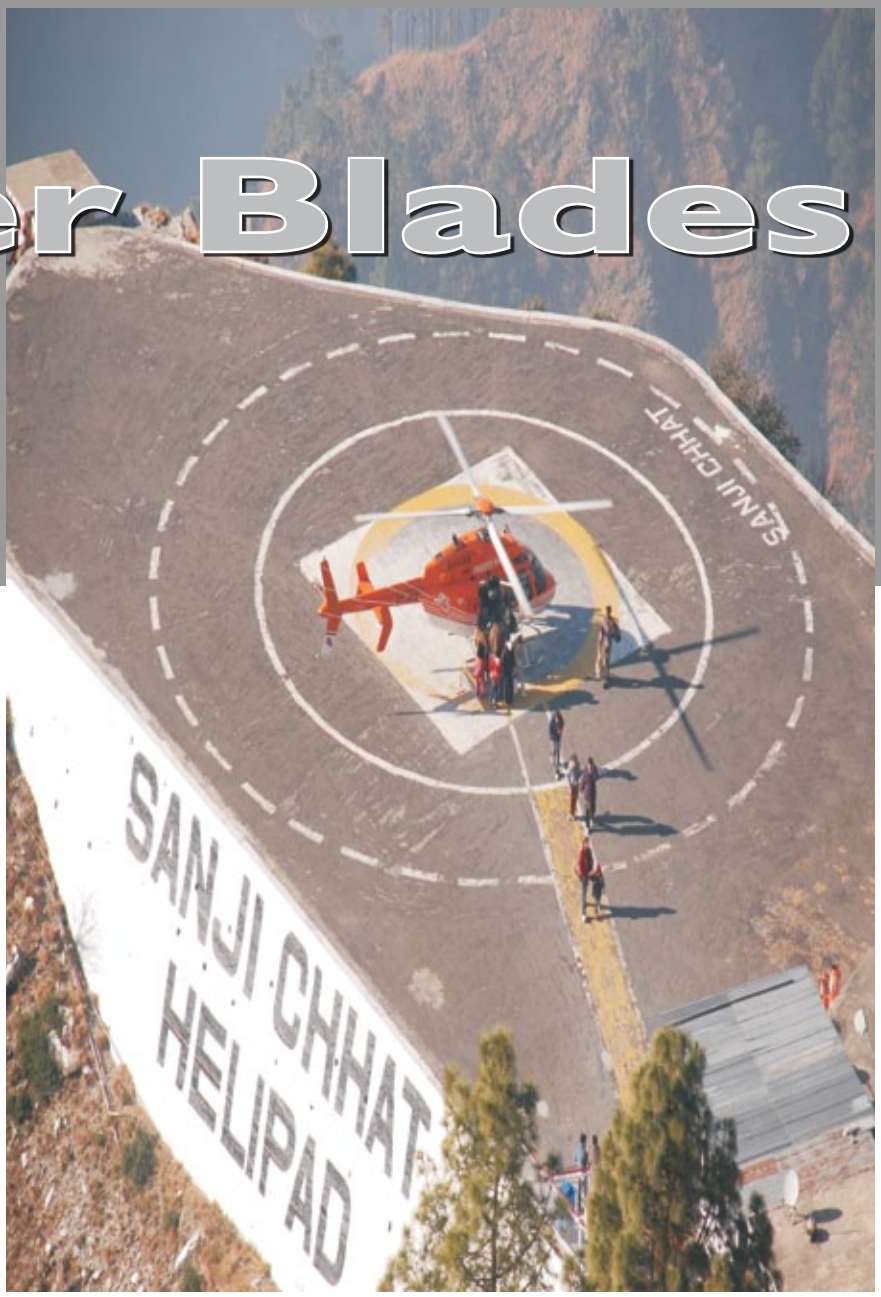
The tandem rotor design has been in operation since the 1960s, but new production aircraft are taking advantage of modern technology designed to meet the modern defence and humanitarian needs well into the future with greater situational awareness and communications capability than ever before. Modern tandem rotor helicopters now have fully integrated, digital cockpit management systems, long-range fuel tanks and advanced cargo-handling capabilities that complement their mission performance and handling characteristics. These types of enhancements mean far greater situational awareness for aircrews, improved communications and networking capabilities and mission management improvements.

Following the tsunami disaster of 2005, tandem rotor helicopters have gained high visibility through humanitarian efforts by providing critical search, rescue and recovery missions covering long distances and high altitudes in the rugged mountainous terrain of Afghanistan, and has demonstrated their multimission capability in the rugged high-altitude terrain of Pakistan in relief sorties for earthquake victims , the Gulf Region of the U.S. after Hurricanes *Katrina* and *Rita* and recently during ongoing relief efforts to the earthquake victims of the L'Aquila region in central Italy. Upgrades and new technologies that are emerging mean tandem rotor helicopters will be in service for decades to come and will get better with time. More than a century after tandem rotors lifted off for the first time, the message spinning from these powerful giants is that: tandem rotor helicopters are here to stay.

Dr. Vivek Lall,
Vice President, Boeing
Defence, Space, and Security, India

Silver Blades

Pawan Hans Helicopters mark 25 Years



The first 25 years of India's largest helicopter operator—Pawan Hans Helicopters Limited—is a saga of nation-building and blazing trails in hitherto unexplored regions of the country.

Twenty-five years is too short a time period in the history of a company to achieve national-level success and enter public consciousness. But this is exactly what Pawan Hans Helicopters Limited (PHHL), the national helicopter company of India, has achieved in this short span. It has scripted remarkable success stories in all areas in its domain: heli-tourism, offshore and onshore operations, connecting inaccessible areas of India, providing medical services, aiding in disaster management, facilitating VVIP movement, help maintaining law and order, power-sector operations, and last but not the least, crop spraying. In short, it has been a trusted and efficient partner in nation-building.

Pawan Hans Helicopters Limited was incorporated in October 1985. The Government of India has 78.5 per cent shareholding in PHHL and Oil and Natural Gas Corporation has the remaining 21.5 per cent. PHHL was incorporated with the primary objective of providing helicopter support to the oil sector for its off-shore exploration operations, services in remote and hilly areas, and charter services for promotion of tourism. Pawan Hans is under the administrative control of the Ministry of Civil Aviation, the first ISO 9001: 2000 certified Aviation Company in India.

Over these twenty-five years, PHHL has not only evolved considerably but has also changed the way helicopters make a difference to today's prospering India. It has become one of the key-players in nation-building, and it 'carries the baton' with commendable dedication and commitment. The numbers testify to the role it has been playing in India's success story. Pawan Hans helicopters have flown over 450,000 hours and made over 19,36,000 landings.

The need for expanding its area of operation has inspired Pawan Hans and today, it is involved in disaster management, emergency medical services, VVIP transport, fire services, pilgrimage tourism, connecting interior areas, offshore and onshore oil operations, aerial photography, anti-poaching surveillance, installing power transmission towers, hotline washing of transmission lines, construction & development of heliports, sea plane operations, search & rescue helicopter ops, the scope is vast.

To meet the various requirements PHHL has, at present, 40 helicopters, with more being ordered. The fleet currently comprises 18 Dauphin SA-365N, 10 Dauphin AS365N3, 3 Bell 206 L4, 4 Bell 407, 3 AS 350 B3 and 2 Mi-172s, deployed almost all over the country. With the steady demand for its helicopters from various sectors in the country, PHHL has signed contracts for acquiring 15 new helicopters of which delivery of 5 helicopters have already been made and PHHL has plans to expand its fleet by 100 helicopters in the next few years.

With one of the largest Dauphin fleet in the world, with 28 helicopters, PHHL has signed a purchase contract for another three single-engine AS350 B3 Ecureuils, 7 Dauphin SA365N3 with Eurocopter and 2 Mi-172 helicopters with Russian

pawan hans

Helicopters. It has also announced the formation of two joint-ventures (JV) with Eurocopter for Maintenance Repair and Overall (MRO) and training. Both JVs were to be fully in place by the end of 2010. In India, PHHL serves as Eurocopter's approved Dauphin Maintenance Center.

Pawan Hans has made remarkable progress in its performance from 2006-07 to 2009-10. During this period the company's fleet serviceability increased from 66 per cent to 83.20 per cent, directly translating into the highest-ever fleet deployment and utilisation of helicopters, and growth in Pawan Hans' operating revenue. The company's operating profit have grown exponentially from Rs 2.78 crore in 2006–07 to Rs 34.0 crore in 2009–10. The operating revenue increased from Rs 208.83 crore in 2006–07 to Rs 382.0 crore in 2009–2010.

A heliport is being built at Rohini which would cover helicopter operations, MRO and training academy for pilots and technical personnel. It will be a state-of-the-art Feeder Hub Centre where helicopter maintenance facilities, parking and a business centre are planned. States of Maharashtra and Haryana have also shown interest in Pawans Hans for setting up heliports and helipads.

Pawan Hans has been instrumental in popularising heli-tourism in India whose helicopters make more than 60 trips to and from the Mata Vaishno Devi Shrine, carrying over 600 passengers. The costs of this travel is Rs 2,450 for a return trip with priority darshan for pilgrims. From April 2008 to date, PHHL has transported more than 371,101 passengers to and from the shrine. The company has carried more than 9,000 passengers in the last season to Kedarnath.

Pawan Hans has been the key player in the offshore sector and has maintained its position by securing more contracts with the expansion of its fleet, infrastructure and expertise. Pawan Hans provides helicopter support services to ONGC and effectively operates Dauphin helicopters carrying men and essential supplies around the clock to drilling rigs at Bombay High and other offshore operational areas.

PHHL is also helping the power sector. It is involved in hotline washing i.e. washing insulator and cables under live-current conditions, inspection of transmission lines and distribution system and erection of transmission towers and laying of high-tension cables. Since November 2008, PHHL has provided valuable services for hotline washing for Power Grid Corporation Ltd. (PGCL), deploying one Bell helicopter, fitted with specialised equipment to clean the insulator ring using a seven-meter boom and de-mineralised water. The crew and equipment for such specialised task have been arranged from New Zealand.

This service is presently being done in North India, where fog and air pollution from industries get deposited on insulators thereby causing power lines to trip. Before PHHL's initiative, PGCL had to manually clean these insulators for which the power had to be shut down.

PHHL has cleaned 1774 high-tension towers in Delhi NCR region (where the insulators range from 400 KV to 500 KV) in 338 hrs. and from 22/10/2008 to 21/3/2009 cleaned 1249 towers in the Kanpur area in 124 hours. At the same time, the prevention of tripping of the Northern Grid during these seasons with the help of this service is another feather in PHHL's cap.

As the role of helicopters increases, an institute to train required technicians becomes necessary. The Directorate General of Civil Aviation-approved Pawan Hans Helicopters Training Institute will provide the Basic Aircraft Maintenance Engineering Licences preparatory course for purpose of acquiring AME Licences as per Aircraft Rule 61 and CAR guidelines in this regard. As part of the existing training school, Pawan Hans will provide On the Job Training (OJT) within its own maintenance set-up as part of the training course. Maintenance infrastructure and workshop facilities are available at Mumbai which will provide comprehensive training to the candidates.

For maintenance and repair of its helicopter fleet. Pawan Hans has its in-house facilities for different types of helicopters, cover instruments, electrical, safety equipment, synthetic panel, component repair shop, Spectrometric Oil Analysis Procedure Lab and radio including Full Test Data checks, at Mumbai. At the same time, all periodic inspections, as well as overhaul, are also carried out in-house by Pawan Hans. The company is an approved Maintenance Centre to carry out servicing of the Dauphin series helicopters and is part of the Eurocopter Network of Authorised Maintenance Centre (AMC) worldwide to carry out the servicing in India and other South East Asian countries.

Pawan Hans Helicopters Limited has been in service to spiritual tourism in India transporting pilgrims to religious places, be it the Mata Vaishno Devi Shrine and the Amarnath Cave in Jammu and Kashmir, or Shri Kedarnath in Uttarakhand.

PHHL Mi-8 in the north-east.

IBAE

The nether world of electronic warfare

Electronic Warfare (EW) is becoming increasingly vital in the defence industry and is poised for transition to easily-upgradeable, standardised and modularised systems. The EW market is displaying dynamic trends and recently, an array of new technologies have emerged for harnessing the electromagnetic spectrum (EMS) and counter of enemy weaponisation. According to *Visiongains,* "global government spending in 2010 on electronic warfare will have reached $7.72 billion."

Generically, electronic warfare encompasses actions that involve the use of electromagnetic energy to exploit, reduce, prevent, or determine hostile use of the electromagnetic spectrum. Electronic warfare consists of three aspects, being Electronic Attack (EA), Electronic Protection (EP) and Electronic Warfare Support (ES). EA includes radar jamming and deception; anti-radiation missiles (ARM); directed energy (DE) weapons; flares and counter radio controlled improvised explosive device (RCIED) systems. EP consists of spectrum management; electromagnetic hardening; emissions control; and wartime reserve modules. ES involves electronic reconnaissance; electronic intelligence (ELINT) and electronics security.

"The United States is the chief proponent of EW, but emerging powers such as China and India seek to improve their military capabilities, they will necessarily focus upon this aspect of modern warfare," according to *Visiongain*. Meanwhile, as Russia too seeks to refine its electronic warfare capabilities, European Union nations are well aware of the need for developing EW capacities, but their efforts have been hampered by budgetary restrictions.

Israel is a key player in EW systems. Air power plays a central role in the maintenance of Israel's military dominance over its neighbours, which means that sophisticated EW systems have become a necessity for the nation. "Even as countries move to reduce defence spending in the face of economic pressures, electronic warfare still promises to receive high priority given its acknowledged centrality to dominance over the modern battlefield."

Thorough analysis of governmental spending, policy and procurement programmes and an in-depth examination of the market potential from 2010-2020, it's estimated that global government spending on electronic warfare will reach $8 billion in 2011 itself.

RF jammers and other EW technology will create a $28.4 billion market over the next decade, as purveyors of electronic countermeasures (ECM), radar warning

ELTA Systems lead in defence electronics

ELTA Systems Ltd., a group and subsidiary of Israel Aerospace Industries, is one of Israel's leading defence electronics companies and a global leader in its area of expertise. ELTA operates as a Defence Systems House, focused on electromagnetic sensors (Radar, Electronic Warfare and Communication) and integrated solutions. ELTA Systems' products are designed for Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR), Early Warning and Control, Homeland Security (HLS), Self-Protection and Self-Defence, and Fire Control applications. ELTA Systems' products include systems, subsystems and critical technological sub-assemblies and components, designed and produced in-house. These capabilities enable ELTA to provide comprehensive solutions and manufactured products and systems tailored and adapted to the special requirements of customers and users, thereby creating a unique competitive advantage. ELTA Systems has a variety of unique technological excellence centres, as well as state-of-the-art facilities and national infrastructures. ELTA operates a worldwide marketing network, which also includes customer service and after-sales support activities.

AERO INDIA SPECIAL

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receivers (RWRs), electronic support measures (ESM), and other EW systems produce about 45,000 systems, according to *Forecast International.* The nation's top electronic warfare systems suppliers (Northrop Grumman, BAE Systems, Raytheon, ITT, and Lockheed Martin among them) will continue producing missile countermeasures systems over the next 10 years, as well as developing next-generation EW technology.

The U.S. Department of Defence (DOD), for example, will spend more than $560 million over the next three years to buy Northrop Grumman's Large Aircraft Infrared Countermeasures (LAIRCM) system for as many as 444 aircraft. In addition, DOD will choose contractors within the next two years to develop and build the Next-Generation Jammer (NGJ). "While production of critical EW systems like counter-IED and IR-guided missile jammers will be high over the next few years, several R&D programmes are in a competition phase that will eventually result in billions of dollars in revenue for the companies chosen to supply technologies for them," stated Andrew Dardine, senior analyst at *Forecast International.*

The U.S. Navy in early 2009 awarded NGJ research contracts to teams led by BAE Systems, ITT, Northrop Grumman, and Raytheon. By late 2012, the Navy plans to award an engineering and manufacturing development (EMD) contract to one supplier. The total value of the NGJ programme once it gets up and running will be nearly $1 billion.

A competition is in progress to develop the Counter Radio-Controlled Improvised Explosive Device (RCIED) Electronic Warfare (CREW) 3.3 'system of systems'. Naval Sea Systems Command in 2010 awarded contracts to ITT Force Protection Systems and Northrop Grumman Space and Mission Systems for CREW 3.3 System of Systems development.

"BAE Systems and Northrop Grumman are among the top producers of the EW technology covered in this analysis, being major developers of key jammers, RWRs and ESM systems for new aircraft such as the F-35 Joint Strike Fighter (JSF), the F-22A Raptor and replacement for the U.S. Navy's EA-6B Prowler, which is the EA-18G Growler," continued Andrew Dardine.

Elisra's Intelligence Solutions

Elisra's customised, integrated intelligence solutions operate in the densest, most demanding of electromagnetic environments, deliver fast and accurate detection of the most sophisticated transmissions, and reliably defend against a broad range of dynamic threats.

The 'SIGINT for Mission Aircraft' combines advanced COMINT and ESM/ELINT systems into a unified system, presenting a new level of capabilities that provide a fast, complete and accurate intelligence picture for mission aircraft. SIGINT payloads for UAS platforms include Emerald AES-210V (ELINT) and SkyFix (COMINT) systems, meeting the full range of SIGINT mission requirements. Lightweight and modular, they detect, identify, and locate ground-based, airborne, and ship-borne radars and communication emitters, and are easily installed and remotely operated from a ground control station.

EW systems produced by top-ranked BAE Systems are also being installed, or are about to be installed, on a significant number of helicopters and military transport aircraft. The company's involvement in these critical areas as well as development of important countermeasure systems gives it a projected 10-year market share of 24.7 percent, representing an estimated value of $6.9 billion.

Like BAE Systems, Northrop Grumman retains a high ranking in this analysis because of its involvement in some of the most important missile countermeasures systems in the development pipeline. The Large Aircraft Infrared Countermeasures System (LAIRCM) is currently intended for C-17, C-130, C-5, KC-135, and Boeing 737 Wedgetail AEW&C aircraft, and is in consideration for an even wider selection of aircraft.

Based on current plans, the system represents a potential 10-year value of some $412.5 million for the company. Likewise, an estimated 186 units of the company's ALQ-218, an important RWR system and the heart of the EA-18G Growler are expected to be produced during the forecast period, at a projected value of $979.6 million.

Besides BAE Systems, the other major international players include Thales, Sweden's SaabTech and Israel's Elta Electronics. Israel continues to demonstrate its major player status in the EW market. The company's EL/L-8222 jamming system continues to be used in upgraded Israeli Air Force F-15 fighters and is also evidently being ordered by nations including Venezuela and Australia. More than 200 additional EL/L-8222 systems, having a projected value of some $345.6 million, will be produced to meet the needs of various international upgrade programmes.

Elisra

The National Endeavour

NAL developing Civil Transport and Trainer aircraft

Based on the address by Dr AR Upadhya, Director at Council of Scientific and Industrial Research National Aerospace Laboratories, Bangalore.

There has been an unprecedented boom in civil aviation in India. According to recent statistics from the Ministry of Civil Aviation, DGCA, and AAI, the country's domestic airlines carried 419.34 lakh passengers between January and October 2010, up 18.3% compared with the corresponding period last year. The number of aircraft in the country increased from 125 to 400 in the last 3 years and is likely to touch 1000 by the end of next decade.

The Government of India has taken a decision to modernise 32 non-metro airports and renovate another 125 unused regional airstrips in the country. Presently, 83 airports are being served by 9 scheduled airlines. Cargo operations are also set for high growth and there could be separate airlines/subsidiaries for cargo service.

Civil aviation must be seen as a very important component of the nation's economy in addition to providing services. Indigenous civil aircraft design, development and manufacture needs to be an integral part of a long term civil aviation policy for a large country like India. As advancements in several scientific and technological disciplines will take place through an indigenous civil aircraft industry, it will also lead to a number of spin-off applications. India is capable of developing and sustaining a viable civil aircraft industry but this requires sustained efforts, full government support and private industry's participation.

There are number of pre-requisites which need to be fulfilled in order to be successful in the area. There is a need to establish and sustain an appropriate Eco-System in the country, certification Requirements and Procedures need to be established especially owing to collaborations with agencies abroad, while there is another need to seed technology development programmes to cater for the future needs and finally to continue tie-ups with established OEMs for global presence and market/technology advantage.

Civil Aircraft Design and Developments at NAL include a 2-seat ab-initio trainer Hansa-3, 4-5 seat general aviation aircraft NM5-100, a 14-seater multi-role aircraft Saras while work on a 70-90 seater RTA for regional connectivity has begun. Various technologies were also developed like design of composite aircraft structures, integration of small aircraft; lightning protection scheme; innovative vacuum moulding technique processes for fabrication of airframe; maintenance and repair of glass fibre composite structure etc.

The RTA Programme

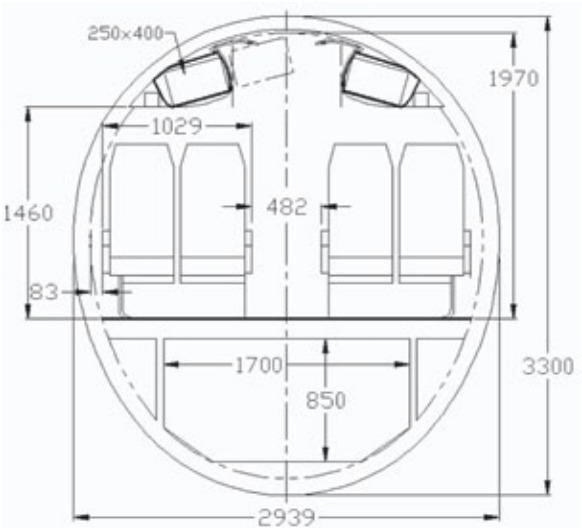
Air transport activity has also seen a surge. As the GDP per capita increases, demand for air transportation (and resulting passenger traffic) increases. Another reason for this is low infrastructural costs for providing air connectivity between city pairs which is far lesser than either road or rail connectivity. Enhanced connectivity vital for rapid intervention during calamities (natural and man made) are also another factor. A significant demand for air transportation is forecast in India and China.

A matter being discussed of late is the national civil aircraft development for regional connectivity for which a high power committee has been formed by the Government to oversee the year-long feasibility study at NAL.

Based on detailed discussions with operators, market analysis for India and internationally, operating economics, regulatory status, environmental constraints, oil price forecasts, competition analysis and technology requirements, a set of requirements for the new regional aircraft has been arrived at. The requirements entail 70-90 seats, lower life cycle cost, operations from unequipped airfields with short runways, noise and emission regulations, cabin comfort and all weather operations. There is need for development of an anchor civil aircraft programme for India in order

Basic specifications: Turboprop and Turbofan variants of the RTA

Parameter base aircraft	Turboprop ATR-72-500	Turbofan Embraer-170
Pax capacity variants		70 & 90
Average weight of Pax+Bag		95 kg
Cargo carrying capability		1000 kg
Acquisition Cost Reduction		25%
Operating Cost Reduction		25%
Maintenance Cost Reduction		25%
Field Operations	Ability to operate from ill equipped airfields in near all-weather conditions(CAT-II landing without any ground support)	
Range with max passengers	2000 km	2500 km
Cruise TAS ~750 kmph(M=0.7)	³ 550 kmph	
Cruise Altitude	25,000 ft	35,000 ft
Ceiling Altitude	30,000 ft	41,000 ft
Takeoff Balanced Field Length SL, ISA+15°C, MTOW		
90 Pax variant	1400 m	1400 m
Approach CAS, MLW 90 Pax variant	115 kts	125 kts
Cabin Noise		74 dbs
External Noise Stage IV		Meet or exceed
Emissions Reduction quantified		To be
Cabin air conditioning	Superior as compared to ATR-72-500	



to facilitate the development of a civil aviation industry, enhance knowledge and skills in the sector and for employment generation.

With specific focus on the RTA-70, a number of technologies are also being evaluated including fly-by-wire flight control system, next generation power plant, low drag configuration, lean ground infrastructure ESVS, more electric aircraft systems, composite airframe, active vibration and noise control, different coatings such as self clean, deicing and abrasion resistant coatings, open distributed modular avionics, advanced display systems and low cost HUD. The objective is to reduce maintenance by 25%.

There is a tremendous possibility for small aircraft development in India arising from a number of factors. India has extensive and valuable experience from indigenous military programmes like the Tejas LCA, Dhruv ALH and IJT. It already has a launch pad from very small civil aircraft programmes like NAL's Hansa, Saras, the NM5, civilian version of HAL's Dhruv helicopter and HAL's Do-228. There is also high market potential with growing civil aviation traffic, income, demand for mobility and industrial/commercial growth. These factors coupled with increasing private industry interest and participation plus the potential of government participation makes the future very exciting.

The Director of NAL Dr AR Upadhya explaining main features of the RTA-70 turbo-prop version.

However, along with such potential there also emerge certain challenges in civil aircraft development programmes in India. There is no legacy of medium/large civil aircraft programme experience or expertise. There is also lack of a database, design / manufacturing infrastructure and certification expertise. The absence of major initiatives from the government and private industries is a major drawback, which has to be redressed.

"Higher and Further": HAL enters its eighth decade

Based on the address by Mr. Ashok Nayak, Chairman, HAL

Set up in December 1940, HAL has just marked 70 years, having moved from its simple beginnings with manufacture of Harlow trainers, Curtiss fighters and Vultee bombers to the post independence Prentice trainers and Vampire jet fighter-bombers. HAL soon designed its own aircraft, the HT-2 and went on to design the Pushpak sports aircraft, Krishak light observation aircraft and Basant agricultural aircraft.

The HF-24 Marut was India's first indigenous jet fighter, with 147 produced and later around 80 Ajeet light fighters, evolved from the Gnat. HAL has had tremendous growth in the past six decades, it has transformed into a diversified Global Aerospace Company building 3rd and some 4th generation multi-role fighters, and expanding its Helicopter Complex (the Dhruv advanced light helicopter is its 'flagship' programme) maintaining continued efforts on research and development.

HAL is working towards a major capability build up over the next years. From repair and overhaul of the Dakota and Liberator to licence production of Vampires, Gnats, MiG-21s, Maruts, Kirans, HPT-32s, there is now development of the Tejas LCA, HTT-40, HJT-36 intermediate jet trainer, continuing upgrading technology of Su-30MKI, co-development with international partners of Fifth Generation Fighter Aircraft (FGFA), Multi-role Transport Aircraft (MRTA) and the Indian Multi Role Helicopter (IMRH).

HAL has produced 11 types of fighters including the Vampire, Gnat, Marut, Ajeet, MiG-21FL, MiG-21M, MiG-21bis and MiG-27ML. The Jaguar is a Deep Penetration Strike Aircraft whose strike, maritime and trainer versions have been manufactured by HAL under licence from British Aerospace. The Su-30MKI is currently under production, a two-seat, multi-role fighter aircraft powered by two AL-31FP turbofan engines with vectored thrust. The Tejas Light Combat Aircraft (LCA) is arguably the world's lightest, multi-role, supersonic combat aircraft designed and developed by the Aeronautical Development Agency and HAL to meet requirements of the Indian Air Force.

HAL has also produced 9 types of trainers including the Prentice, HT-2, Kiran Mk.I/IA, Kiran Mk.II, and HPT-32. The Hawk Mk.132 is being built by HAL under license from BAE to meet the Advanced Jet Trainer requirements of the Indian Air Force. The first Hawk was handed over to the IAF on 14 August 2008. Currently under development are the HJT-36 intermediate jet trainer (IJT) and HTT-40 basic trainer.

As for transport aircraft, the Avro (later HS, BAe) 748 was HAL's first venture in this field followed by the Dornier Do228, a light transport aircraft manufactured under licence from Germany. Functional versatility with low operating costs makes the HAL-Dornier 228 adapatable for a wide variety of roles including regional air services, staff transportation aircrew training, maritime surveillance, search and rescue and for observation and communication

The HJT-36 intermediate jet trainer

An Army Dhruv Advanced Light Helicopter in flight display

duties. Its Garrett 331-5 turboprop engines, avionics and accessories are also manufactured by HAL.

HAL manufactures three types of helicopters: the licence-bulit Chetak and Cheetah, which were followed by the Dhruv advanced light helicopter. The LCH and LUH are under development. The Chetak (Alouette III) is simple in design, highly manoeuvrable and well suited for flying in various conditions. The Cheetah (Aerospatiale Lama SA315) is a light weight and high performance helicopter specially designed for operations in high altitude conditions. What puts the Dhruv ALH a generation ahead of other helicopters is its advanced airframe design, crash worthiness features, hinge-less main rotor, bearing-less tail rotor, anti-resonance isolation system, extensive use of composites, flight control system, integrated dynamic system, self-sealing fuel tanks and optimised blade tip shape. This unique combination ensures high performance and survivability, lower operating costs, better comfort and versatility at the most competitive prices.

The Light Combat Helicopter (LCH), designed and developed by the RWRDC of HAL is a dedicated attack helicopter, based on the ALH. The helicopter uses maximum composites and flat panels for low RCS and low glint while affording armour protection against small arms fire. The LCH has a glass cockpit, self-protection system with radar and laser warning systems, missile approach warning plus a flare & chaff dispenser. The LCH has been designed for anti-armour operations, Suppression of Enemy Air Defence (SEAD) operations, as escort for Special Heliborne Operations (SHBO), Offensive Employment in Urban Warfare and Counter Insurgency operations and armed reconnaissance roles.

HAL has embarked on development of a Light Utility Helicopter (LUH) to meet the exacting requirements of the Indian Armed Forces for another 187 helicopters. Preliminary design studies have begun on a 3-tonne helicopter powered by a single HAL/Turbomeca Shakti engine. The aircraft will have a range of up to 500km (270nm) and a 500kg (1,100lb) payload, the first example to fly by 2015.

The Indo-Russia UAC/HAL Il-214 Multirole Transport Aircraft (MTA) will be turbofan-powered (multi-role) transport aircraft which will be co-developed by a joint-venture formed by the United Aircraft Corporation (UAC) of Russia and Hindustan Aeronautics Limited (HAL), both companies investing US$300 million each in the joint venture. The MRTA is expected to fly by 2014 and inducted after development trials.

The Sukhoi/HAL Fifth Generation Fighter Aircraft (FGFA) is to be developed by Russia and India, a derivative project of the PAKFA (official designation for the Indian version is FGFA). While the Russian version will be a single-seat fighter, the Indian variant will be of twin-seat configuration.

HAL is to develop a Medium Lift Helicopter in the 10-15 ton class, to be offered to the Navy to meet its requirement for Sea King replacements. HAL has also proposed the IMRH (Indian Multi Role Helicopter) as a co-development/co-production project, with a foreign partner, as the Mil Mi-8/Mi-17s replacement.

HAL has also formed a number of strategic alliances with the Indian Space Research Organisation (ISRO) for its PSLV/GSLV space launch vehicles and INSAT/IRS satellites; with DRDO for the Prithvi, Trishul, Nag and Akash missiles; with Aeronautical Development Establishment for the Lakshya (PTA) and Nishant; with Vikram Sarabhai Space Centre for materials, adhesives, actuators, control valve, gyro components, etc.

Mock up of HAL's proposed Light Utility Helicopter

Focus on Core Technologies

Excerpts of lecture by Dr MM Pallam Raju, Minister of State for Defence at 'Defcom 2010'

"Held during the Centenary year of the Corps of Signals, this seminar has a special significance. One of the most prestigious communications project conceived by the Corps, the Tactical Communication System (TCS) is well on the way after some initial delays. This project is being progressed under the 'Make' category and provides the Indian Industry an excellent opportunity to seek its share of defence production. Defence Procurement Procedures are evolving and a definite role for the Indian Industry in Defence Procurement is emerging concurrently with the role of Defence Public Sector Undertakings (DPSUs)."

"The Armed Forces, however, will remain a demanding customer both quantitatively and qualitatively. Indian Industry must step in to be competitive and strive at qualitative indigenous competence and self reliance in design and development of military hardware and software including embedded components; a meaningful R&D structure leveraging on the technical knowledge and competence of our internationally acclaimed IT professionals and synergy among various agencies to achieve the shared goal of indigenisation and self reliance."

"The industry must also productionise equipment that meets stringent military standards and provide evidence that the equipment will operate to laid down specifications in the environmental conditions it is likely to face during its useful life. Defence equipment manufacturers and development agencies cannot leave mission-critical performance to chance and must therefore set up state of the art testing facility for quality assurance. They must also effectively meet the current and futuristic needs of our services to enable them to address the complexity and interdependency of converged connectivity and networking of modern weapon systems thus contributing to enhancement of the operational capabilities and combat readiness of our Armed Forces."

"India is fast developing into an international manufacturing hub with proven skills in design, creativity and quality. The Indian Industry has also productionised quality equipment and security procedures of international standards which qualify them for assuming greater responsibility in defence production. In order to synergise and enhance the national competence in producing globally competitive defence equipment without time and cost over-runs, the government is exploring all viable initiatives such as formation of consortia, joint ventures and public-private partnerships."

"The private sector has distinct strengths in Information and Communication Technology. Since the Armed Forces are on the threshold of an exciting new era of netcentricity in which they hope to network all sensors, shooters and commanders on converged infostructures, they expect substantial participation by the private sector. While accepting the necessity, we must appreciate that providing connectivity for strategic and tactical networks is a challenge, as dispersed forces operate over large geographical areas with diversities in terrain, weather, local conditions and operational uncertainties."

"Military networks are larger and more complex than ever before and are becoming increasingly mission-critical under the emerging doctrine of network-centric operations. The proliferation of Networks has also brought in its wake new threats and challenges. Cyber security has become an area of great concern and importance. A need therefore exists to find effective ways to protect and defend information and information systems by ensuring their availability, integrity, and confidentiality; a challenging objective even with the most advanced technology and trained professionals. Hence the networks have to be designed ab-initio to provide foolproof security and resilience both to guard against leakage of information as well as prevention of disabling attacks on those networks."

"While the desire of the ICT industry and the military for smaller and lighter equipment covering more bands and carrying more voice and data than the last generation of communication and networking elements is understandable, there is also a need to factor in existing and legacy systems which must be supported and integrated with the modern designs and concepts which must facilitate interoperability with the legacy military systems and complementary products of other manufacturers."

"An endeavour has to be made by Indian Industry to focus on core technologies and be geared up to provide life time support to equipment and upgradation of technologies. While doing so, there should be no requirement of looking over our shoulders to foreign OEMs and technology providers. India's industry is mature enough to take on this task with indigenous resources and efforts."

Rada

ATR Special Versions

Vayu's interview with Maurizio Rosini Head of Alenia Aeronautica's Military Transport and Special Versions Aircraft Product Unit

VAYU: What is Alenia Aeronautica's role within the ATR programme?

Alenia Aeronautica has been EAD'S partner in the ATR equal joint venture for over twenty years. The models currently in production are ATR 42-500s, ATR 72-500s and the new ATR – 600 Series.

Alenia Aeronautica's facilities involved in the ATR programme are Pomigliano d'Arco (near Naples), which makes the cockpit, front and central fuselage sections, fuselage assembly and some tests; Nola (near Naples), which makes fuselage skins and frames, longerons and intercoastals; Casoria (near Naples), which makes parts of fuselage metal sheets and wings; Foggia (in the Apulia Region) manufacturing composite parts of rudder, elevators and horizontal stabilisers and manufacturing and assembly of the vertical fin; Turin (in the Piedmont Region), for steel pipes for high-pressure and welded pipes for low pressure.

On 1 October 2009, ATR presented the new-600 series whose characteristics are greater strength, higher performances, lower maintenance and fuel costs, a new-generation avionics suite, more comfortable cabins and lower C02 emissions per passenger. The first new-series aircraft will enter into service in 2011. Till now ATR has registered orders for around 60 new airplanes.

VAYU :Summarise the characteristics of the ATR Special Versions developed by Alenia Aeronautica.

The ATR 42MP (Maritime Patrol), is an ad-hoc version developed by Alenia Aeronautica, able to fulfil different maritime roles of the ATR 42, regional turboprop aircraft made by the Italian-French joint venture ATR (Alenia Aeronautica/ EADS). The aircraft, with its low operational costs is capable of accomplishing maritime patrol roles such as sea surveillance; vessels search and identification; search and rescue (SAR); drug, smuggling and piracy control; environmental control (pollution by oil and chemical substances); economic exclusive zone patrol (fishing, off-shore platforms) along with secondary missions including transport of personnel, paratroopers and goods; cargo, medical evacuation and civil protection.

Alenia Aeronautica has supplied four ATR 42 MPs to the Italian *Guardia di Finanza* (customs police) and three further aircraft are in service with the Italian Coast Guard. Recently Alenia Aeronautica delivered the second of two ATR 42 MPs ordered by the Nigerian Air Force, while the Libyan General Security agency has ordered one in 2008. The Italian *Guardia di Finanza* flies the aircraft in the role of medium-long range maritime patrol, illegal traffic control, search and track, classification, identification and detection of surface vessels. The aircraft in service with the Italian Coast Guard are used for SAR (Search and Rescue) operations, maritime patrol, vessels search and identification, sea pollution monitoring, protection of the marine eco-system and, in general, for sea and coastal surveillance. The structural modifications implemented by Alenia Aeronautica on the ATR 42 MP envisage the installation of the mission system ATOS (Airborne Tactical Observation and Surveillance System) produced by SELEX Galileo (a Finmeccanica company). The aircraft is equipped

with modern navigation systems, search radar, electro-optical and electro-magnetic surveillance, communication (voice and data) and registration systems, all integrated in the mission management system.

The Alenia Aeronautica's ATR 72 ASW (Anti-Submarine Warfare), a highly effective mid-size anti-submarine aircraft, with competitive acquisition and operational costs, is a special version of the ATR 72 turboprop regional aircraft made by the Italian-French ATR joint venture (Alenia Aeronautica/EADS). The ATR 72 ASW is the only modern, mid-size aircraft available in the market, equipped with state-of-the-art mission sensors. Its essential mission is Anti-Submarine Warfare. The aircraft is also able to carry out other roles including maritime patrol (already under taken by the ATR 42 MP version) with the advantage of greater autonomy and bigger capacity, thanks to its stretched fuselage; vessels search and identification, search and rescue, drug, smuggling and piracy control, environmental control (pollution by oil and chemical substances) maritime patrol roles, economic exclusive zone patrol (fishing, off-shore platforms). Ten ATR 72 ASWs have been ordered by the Turkish Navy under the "Meltem - 3" programme.

VAYU: What does Alenia Aeronautica plan for their ATR Special Versions?

Alenia intends to play an important role in the market of special version aircraft. The maritime surveillance market in the next 20 years will require 300 aircraft in the ATR-class and within this Alenia Aeronautica is in a position to receive at least 100. The ATR special versions are excellent aircraft, with satisfied customers. We have good chances of sale, for both maritime patrol and anti-submarine versions.

VAYU: What is the export potential for these aircraft? Do you have negotiations underway with some countries in particular?

Yes. We are talking to countries including Oman, India, Malaysia and Greece.

VAYU: What are the opportunities for Alenia Aeronautica's ATR Special Versions in India?

The Indian Navy and Coast Guard are looking for a new medium-range aircraft and there is only one real cost-effective solution that can also offer the added value of state-of-the-art technology, operational effectiveness and a common platform for an efficient technical support, training and logistics. Alenia Aeronautica has achieved a notable success in the region with the regional aircraft made by ATR (equal joint venture between Alenia Aeronautica and EADS), around 100 of these aircraft are in service with the major national airlines of the region.

The ATR 72ASW and ATR 42MP, the former for the sea warfare requirements of the Navy and the latter for the maritime patrol requirements of the Coast Guard, have better endurance, much better hot and high performances, higher speed and will not bear the heavy burden of a useless rear ramp that other possible contenders have. They are more suitable for the typical low-level, long, all weather, maritime patrol missions than their competitors, some of which are derived from regional jets or business jets, with their long and thin wings optimised for high level, fast, cruise flights. They are only marginally slower than a jet on the typical operational profile (5 minutes out of a one-hour trip when operating at 200 NM from the base) but much more - up to 40% - fuel efficient. And, last but not least, the ATR are "combat proven". The Italian Coast Guard and the Italian *Guardia di Finanza* have been having 7 aircraft in service for some years, routinely performing border control and protection tasks and with an excellent record in operational missions against smugglers and illegal immigration.

Israel Aerospace and Defence Systems showcased

As always, the Israel national pavilion showcases "exceptional systems" developed by Israel's Aerospace and Defence Industry. At Aero India 2011 and coordinated by SIBAT, the Defence Export and Cooperation Agency, companies taking part includes :

Aeromaoz Ltd.
Aeronautics Ltd.
Astronautics C.A Ltd.
Controp Precision Technologies Ltd.
Elbit Systems Ltd.
IAI – Israel Aerospace Industries Ltd.
IMI – Israel Military Industries Ltd.
Orbit Communication Systems Ltd.
Rada Electronic Industries Ltd.
Rafael Advanced Systems Ltd.

The smart new cockpit of the Grob G.120TP on display at the Farnborough Air Show 2010.

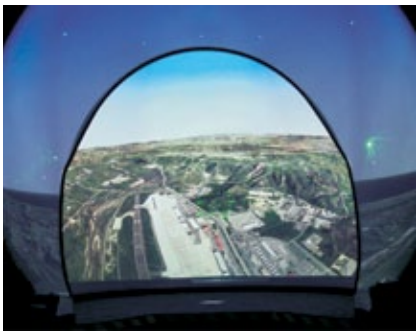
Elbit's "Total Training Experience"

Elbit Systems, an acknowledged leader in the field, builds on over three decades of experience in training and simulation programmes, and offers comprehensive solutions that have the unique advantage of being based on actual, operational systems that the Company develops, manufactures and supplies. The main multimedia presentation at the Show focuses on the Company's pilot training capabilities, demonstrating a pilot's progression from preliminary cadet training to live network-based joint operation training, while eliminating training gaps.

Elbit Systems and Grob Aircraft AG have developed a new cockpit which features an Elbit Systems glass cockpit with 3 digital 6"x8" independent smart, multi-functional displays (SMFD) enabling maximum situational awareness and flight safety with a high level of mission simulation and capability for visual tactical training in the G.120TP trainer aircraft.

Controp unveils aerostat specific EO payloads

Controp has unveiled a new and unique EO multi-sensor payload system designed specifically for persistent surveillance aerostat applications. Since it was first introduced, SPEED-A has been operational with several operators in Israel and Afghanistan, on border and force protection applications, providing unsurpassed persistent surveillance performance. CONTROP has recently delivered this aerostat-optimised payload to another customer, for use with persistent surveillance applications.



This ultra-lightweight payload (23kg) uses five-axis stabilisation (yaw, pitch and roll). Unlike conventional stabilised payloads where line of sight is gyro-stabilised in pitch and yaw, the Speed-A is also controlled in the roll axis, for optimal use with tactical aerostats, offsetting the tumbling motion caused by the tension on the tether.

The high stability provided by the Speed-A system's facilitates some advanced functions built-into the system, including automatic movement detection and panoramic scan, contributing to improved surveillance efficiency even in high wind conditions. 'Speed-A' has been fielded with IDF aerostats this year.

At Aero India 2011 Controp debuts the new Speed V stabilised EO/IR observation and panoramic scanner, developed specifically for vehicular applications. This lightweight (24kg) EO/IR gyro-stabilised system provides long range observation, deployed on vehicular mounted telescopic masts. It is designed for intelligence gathering missions, as well security and early warning, conducting panoramic scanning for intruder detection and troop protection. Speed-V combines capabilities, technologies and expertise gained from Controp's Spider systems and the lightweight Speed-A Aerostat Camera System, making Speed-V the optimal lightweight, high performance stabilised EO/IR camera system for mounting on vehicle masts for long range mobile applications. Applications for the SPEED-V include mobile security missions, mobile coastal and border surveillance, ground troops security, force protection and more.

Elbit Systems mission training centre

The Israel Air and Space Force (IASF) has approved the 'display system'

milestone for Elbit Systems' mission training centre for pilots of F-16C/D and F-16I fighter aircraft. The ISAF approval is an important milestone towards the establishment of a full-fledged mission training centre and is a part of a $55 million contract previously awarded to Elbit Systems by the Israeli Ministry of Defence.

The display system was set up in cooperation with Barco, a global technology company that designs and develops visualisation solutions. It includes a 360 degree field of view (FOV) that simulates the FOV of an F-16 crew member.

Elbit Systems' Targo Helmet Mounted Avionics (HMA) will also be a part of the system. Targo is a comprehensive solution for training aviators to master cutting edge platforms and systems in a cost effective package that covers all stages of the mission, including planning, rehearsal, flying and debriefing.

1000th Rafael's Litening pod

Rafael Advanced Defence Systems have marked the sale of their 1000th Litening

Pod. Litening is one the world's leading, and most widely-used electro-optic targeting and navigation pod. Used by combat aircraft, Litening provides easy to operate, reliable, day and night precision strike capability, in adverse weather conditions. Following the procurement of the Litening by advanced customers, including Israel, Germany and others, Litening has been a major tool for operational and functionality when Northrop Grumman Corporation and Rafael team was awarded the US ATP-SE competition for the ACC in October 1996.

Litening pods have been procured by 26 countries (including India) and have logged more than a million flight hours. The reliable, easy-to-maintain pods constitute more than 50% of the world targeting pods in use and are currently used in a range of ongoing operations including international peacekeeping forces (International Security Assistance Forces).

IAI in contract for ELM-2105 radars

Israel Aerospace Industries (IAI) has been awarded a contract worth $9 million to provide a foreign customer with its ELM-2105 radar-based border protection system. The radar, which is part of IAI/ELTA's newly developed tactical ground surveillance radar family, has two back-to-back beams, and rotates 360 degrees at an extremely fast speed. These features enhance surveillance and detection probabilities, on the battlefield and in border patrol. The ELM-2105 was chosen by the foreign customer following a rigorous testing period.

"First Look - First Kill"

Raytheon's Sidewinder and AMRAAM weapons

AMRAAM.

Amidst the vast array of armament being offered to the Indian Air Force for the Medium Multi-Role Combat Aircraft competition, one particular short-range air-to-air missile appears to have emerged as "superior solution for the Indian Air Warrior". "Raytheon's AIM-9X Sidewinder is the world's premier 5th Generation IR dogfight air-to-air missiles," said Dave Adams, the AIM-9X programme director. "Most people are familiar with it because it has an extremely high-off boresight capability, thrust-vectoring manoeuverability, internally-stored cryo-engine and an imaging focal plane array." Although the new AIM-9X Block II variant of the Sidewinder, which is part of the MMRCA package, has never been fired in combat, earlier variants of the weapon have scored an estimated 270 aerial victories. Additionally, the AIM-9X has more than a million captive carry hours, thousands of which have been accrued during actual combat missions.

Additionally, like all other Raytheon weapons, Sidewinder is continually and frequently test-fired in a variety of exacting conditions. This testing guarantees the safety of air warriors by ensuring the weapons they train and fight with will perform in a reliable and predictable manner. Much like its namesake, the venomous Sidewinder rattlesnake, Raytheon's Sidewinder carries a bite that is deadly to its enemies. But unlike the snake – or other short-range air-to-air-missiles – Raytheon's Sidewinder can rapidly adapt to new threats.

"It's an all digital missile and is stored in a smart, computerised container," Adams said. "This means that as threats evolve and we develop different uses for the weapon, we can upgrade the missile software without ever taking it out of the box."

If history of the 20th and 21st century has proven one thing it is this: *in order for a nation to win a war on the ground, it must first win it in the air.* And as numerous aerial engagements have demonstrated time and time again, the aviator who sees his enemy first and fires first is most likely to win.

These are lessons the U.S. company Raytheon appears to have taken to heart when it developed the AIM-120 C-7 Advanced Medium Range Air-to-Air missile (AMRAAM), which is part of the U.S. offering for the Medium Multi Role Combat Aircraft competition.

"AMRAAM offers the warfighter a first-look, first-shot, first-kill opportunity," said Cesar 'Rico' Rodriguez, director of Air Warfare Systems international programmes at Raytheon Missile System. "AMRAAM has shot down more than eight fighter/attack aircraft. No other missile in production, and certainly no other missile in development can claim that kind of success rate."

Rodriguez, a retired U.S. Air Force aviator with three air-to-air victories under his belt, one of which was with an AMRAAM, pointed out that no other missile in the world can even come close to matching AMRAAM's hardware reliability of greater than 96 percent.

"AMRAAM has almost two million captive carry hours on fighters and air defence systems and has proven itself as the global standard for safety and combat reliability," Rodriguez said. "On the ground or in-flight, an AMRAAM has never been the cause of a safety mishap. When loaded and fired AMRAAM will accomplish the the mission at hand, as advertised - First Look - First Kill."

Rodriguez added that AMRAAM has been procured by 36 nations and integrated on 13 aircraft, including the F-16 IN, F/A-18 E/F, the Gripen and Eurofighter.

AIM-9X Block II variant of the Sidewinder.

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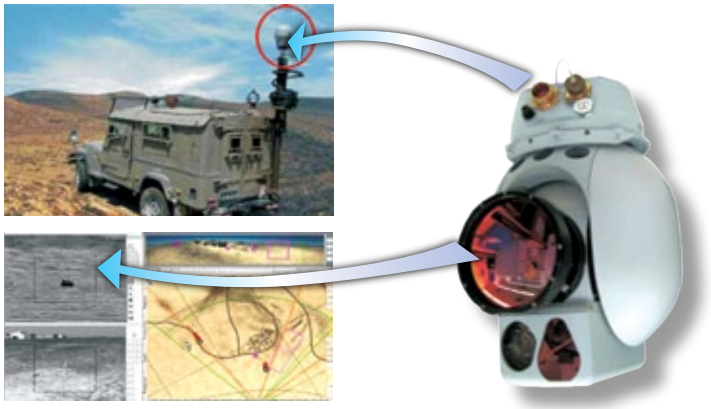
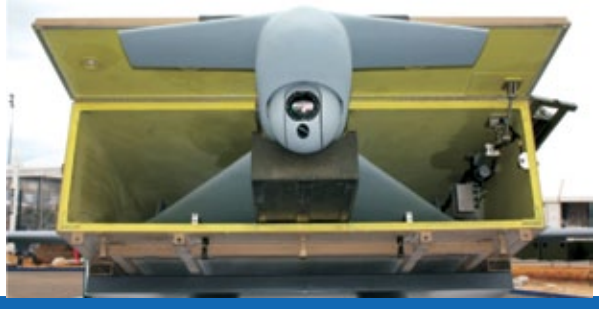
- LASER RANGE FINDERS
- AUTOMATIC VIDEO TRACKER
- DAY COLOUR CAMERA





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Visit us at Aero India 2011 at TATA Chalet

A Holistic Approach
CAE's operational training model

Militaries are operating in increasingly challenging times. Operational demands remain constant as the most important objective for defence forces, yet a range of factors make it difficult for many militaries to 'train as they fight'.

Three critical factors, those of cost, operational demands and environmental concerns, are converging to change the nature of military training. These factors have the combined effect of significantly limiting the amount of 'live' training that can be done on front-line weapon systems. At the same time, operational missions are becoming much more complex and almost always involve joint, multi-service, and multi-national forces. However, without standardised and interoperable synthetic training systems, it is difficult for many militaries to conduct virtual training that is consistent with what they will experience on the battlefield.

There is an increasing tendency on the part of global militaries to look for turnkey or near-turnkey solutions for increased simulation-based synthetic training because both military personnel and procurement budgets are facing operational demands and tighter budgets. The good news, though, is that advances in synthetic training capability over the past several years combined with developments in embedded on-board training is making highly-capable, realistic virtual training systems even more effective.

In many countries, platform-based acquisition of training systems have led to much higher costs and significant wastage, while the lack of interoperable training systems impacts negatively on preparedness and mission readiness. This is because defence forces are unable to train in the manner they would like, which is to train just like they would conduct operations which has led to disparate training systems without consistency in the training infrastructure. In many countries, even though they employ sophisticated, high-fidelity simulators and training systems, there are often complaints on too many different visual systems; databases having proprietary formats; different training management information systems; no interconnectability and networking with training systems; limited re-use of the software in training systems; and courseware being inconsistent.

As India continues major weapon systems acquisitions and modernisation efforts, the time is now for the Indian defence services to seriously consider a more integrated and "holistic" approach to training, which is where an independent training systems integrator that is platform-independent with experience, focus and capability, can help. A training systems integrator, or TSI, can work closely with the government and defence forces to lead the design, optimisation, integration, implementation, delivery and support of comprehensive, cross-platform training solutions.

At the HATSOFF helicopter training centre in Bangalore, CAE and HAL have partnered to develop a turnkey training programme for military and civil helicopter operators.

A Natural Role for CAE

The changing military training paradigm has led to an increasing demand for companies with a range of capabilities and a culture of partnership. A company must have the experience, skills, and capability to design training programmes, create and support the complex integrated ground-based training system and training environment and, where applicable, manage or even provide the associated live training assets. Focused exclusively on simulation and training, CAE is well-placed to serve as a training systems integration partner for militaries as well as original equipment manufacturers (OEMs) and has the ability to leverage relevant experience, innovative technologies, with unparalleled expertise in helping design and develop turnkey training programmes.

A good example is the approach Canada has taken recently for a more integrated and holistic approach to training. Under the Operational Training Systems Provider (OTSP) programme, CAE is serving as the training systems integrator (outside of the platform acquisition) to develop and deliver a comprehensive training capability for Canada's new C-130J and CH-47 aircraft. CAE has overall responsibility for designing, developing and executing the turnkey training required for support of these aircraft and the Canadian Forces over the next 20 years and CAE has partnered with a number of other companies in the country to support this effort.

The Indian defence forces are increasingly aware of the potential of synthetic training, which has resulted in plans to acquire simulators for training purposes. Stand alone simulators for training individuals in improving their technical skills are no longer considered adequate to meet mission training requirements. Tactical trainers along with infrastructure and other facilities on a 'Build, Operate and Maintain' (BOM) basis are being sought to train the forces in operational settings. In fact, such an integrated approach to training holds the promise for India's para-military forces as well, which are increasingly involved in counter terror operations in the country.

BEL

Rolls-Royce: an extended history in India

AERO INDIA SPECIAL

Rolls-Royce has had a long and proud history of service in India. In 1932 the company supplied Gypsy engines to power DH-89 Dragon Rapide aircraft operated by Tata Airlines, the forerunner to Air India and thus began a relationship with India that has continued to grow ever since. Today, there are over 1,300 Rolls-Royce engines in service in India, mainly as a result of long-term defence programmes. However, all four of the company's global market sectors, being civil aerospace, defence aerospace, marine and energy are well represented.

Rolls Royce relationship with the Indian armed forces reflects its broad product range which spans all defence market sectors. Rolls-Royce engines currently power combat, training, transport and tactical aircraft as well as helicopters.

In the defence sector, Rolls-Royce celebrated the 75th anniversary of its partnership with the Indian Air Force in 2008, a milestone that coincided with the introduction of the latest Rolls-Royce engine into the fleet, the Adour Mk.871 which powers the new Hawk Advanced Jet Trainer (AJT). This engine features some of the latest technologies from both the military and civil sectors and will be used in the training of the next generation of Indian pilots who will follow in the illustrious footsteps of the pioneers who fired up their Bristol Jupiter engines as the first IAF Wapiti IIA took to the skies.

During the Second World War and later in the 1940s, many Rolls-Royce powered aircraft were used by the Indian Air Force including the Lysander, the Hurricane, the Spitfire and the Tempest II. In 1948, soon after Indian independence, the jet-powered de Havilland Vampire was introduced into IAF service and over the next decades, Rolls Royce-powered Hawker Hunters, Canberras and Gnats which followed.

Presently, the Indian Air Force operates 120 Jaguar strike fighters which are powered by Adour engines manufactured under licence at Hindustan Aeronautics Limited at Bangalore. In the transport sector the IAF has been flying the EMB-135J Legacy corporate jet powered by the AE 3007 engine since 2005 when it replaced the venerable HS748 as the air force's communications aircraft. With induction of the Lockheed Martin C-130J transport aircraft powered by the AE 2100, Rolls Royce begins the latest chapter of their longstanding partnership with the Indian Air Force.

In the future, opportunities exist for Rolls Royce in the air-to-air refuelling sector for which the Trent 700-powered Airbus A330 has been offered to the IAF, with its significant hot and high performance advantages. This aircraft and engine combination was selected by the UK as its Future Strategic Transport Aircraft in 2008. The Trent 700 is the only engine specifically designed for the Airbus A330 and over 1,300 are now in service or on firm order. The engine has obtained more than 75 per cent of orders in the last three years and in 2010 Rolls-Royce won 14 of the available 15 engine campaigns for the Airbus A330.

In the helicopter market, the market-leading RTM322 helicopter engine has been selected to power over 85 per cent of NH90 customers and approximately 60 per cent of the EH101 helicopter operators. There are strong opportunities for the RTM322 to operate in the Indian environment particularly for maritime surveillance and military tactical transportation.

However, Rolls Royce's activity in India has expanded far beyond the supply of engines, playing a key role in the development of India's indigenous aerospace industry, largely through partnership with HAL which produces Adour engines for the Hawk and Jaguar, as well as delivering components to Rolls-Royce. In July 2010 India ordered a second batch of 57 Hawk AJTs, including 17 that will enter service with the Indian Navy, which also operates the Pegasus-powered Sea Harriers.

We are continuously working at this relationship, to increase indigenous work for HAL and to develop capability across a wider portfolio of manufactured parts. This was further strengthened in March 2010 when the two companies signed an agreement to create a manufacturing joint venture company in Bangalore, *International Aerospace Manufacturing Private Limited* registered in July 2010 to undertake the manufacture of compressor shroud rings. A new purpose-built production facility, incorporating the latest in modern manufacturing techniques, will begin production in 2012.

John Gay
Director Customer Business South Asia-Defence, Rolls-Royce

JMD

BEL's Network Centric Warfare capabilities at Aero India 2011

Akash weapon system

Navratna Defence PSU Bharat Electronic Limited (BEL) will showcase Network Centric Warfare technologies developed in-house at Aero India 2011.

Network Centric Warfare makes use of computer processing power and networking communications technology to provide shared information of the battle space among defence forces. The shared awareness increases synergy for command and control, resulting in superior decision-making and the ability to coordinate complex military operations over long distances.


Thermal imager based integrated observation equipment

NCW solutions on show would include Command & Control System, a major display on Air Space Management; Multi Sensor Tracking, Situation Simulator and Tactical Algorithm for Air Defence applications; Battlefield Management System for supporting military users of all levels in a tactical battle area - from the individual soldier up to the Battalion HQ; and Coastal Surveillance System, an all-weather 24x7 surveillance system for safeguarding the nation's coastline. The system networks sensors such as radars, day & night electro-optical equipment, Automatic Identification System and meteorological equipment present an integrated operational picture of the offshore to the user.

BEL will also showcase its inherent R&D capabilities by demonstrating some of its new products and technologies including Software Defined Radios, Next Generation Bulk Encryptor and High Data Tactical Radio.

Airborne Products on display will include Radar Finger Printing System (RFPS), an airborne equipment that carries out Fine Grain Analysis; Data Link, which provides a common tactical picture across the fleet by enabling exchange of messages and tactical data in a speedy, reliable and secure manner; Digital Flight Control Computer (DFCC), a computer used onboard aircraft for flight control functions; and Identification Friend or Foe, electronic system which determines the intent of an aircraft.

Also on display would be the complete range of Opto Electronic equipment, including Night Vision Devices, Digital Hand Held Compass and Advanced Land Navigation System.


Weapon locating radar

The highlight of BEL's outdoor display will be the entire range of sub-systems of the *Akash* guided missile air defence weapon system for which BEL is the lead integrator. Another major system is Weapon Locating Radar, the state-of-the-art passive, phased array radar which has undergone successful user trials. Both these systems have been designed by DRDO. Mobile Communication Terminal, a multi-layer communication network, will also be on show at Yelahanka.

BrahMos : "the best system in the world"

Dr. A Sivathannu Pillai, CEO and MD Brahmos Aerospace and Praveen Pathak of Brahmos Aerospace with Nikolay Patrushev.

Nikolay Patrushev and Dr. A Sivathannu Pillai

When Mr. Nikolay Patrushev, Secretary of the Security Council of the Russian Federation along with a high level delegation accompanied by Mr. Alexander Kadakin Russian Ambassador to India, visited the BrahMos complex at New Delhi, Dr. A.S. Pillai CEO & MD, BrahMos Aerospace presented the progress made by the JV in the last 10 years and the possible areas for future collaborations. He highlighted the enormous efforts from the Indian and Russian scientific communities to "the best system in the world." Mr. Patrushev lauded that BrahMos is "a remarkable achievement in a short time and the best manner that in which India and Russia can cooperate in high-technologically advanced defence and aerospace products."

Mr. Patrushev said that "the JV BrahMos is a bright illustration of successful collection by Russian and Indian scientists and designers, based on the highest trust and respect. I wish great successes in future ventures in further strengthening of Russia-India friendship."

Mr. Kadakin said that the BrahMos project is "a dream made true by the joint efforts of the Russian and Indian scientists and congratulated the pioneers of BrahMos with their magnificent work." Bringing together the best of the brains of the two countries not only brings down the cost but makes the system developed highly advanced and reliable overtaking other countries. BrahMos is great tribute to the power of scientific communities of the two nations.

Dr. Pillai said that BrahMos is already in service with the Indian Navy in number of ships and also with the Indian Army. He also mentioned that the new ship being built in Kaliningrad has been installed with Vertical launcher and FCS delivered by BrahMos with ITF launch being planned in the Baltic Sea. "We have now 4 versions: sea to sea, sea to land, land to sea and land to land already fully developed and operational. The work on the underwater launch and air-launched version is under progress," he added.

Brahmos Block III version successfully test fired

Block III version of the Brahmos, with advanced guidance and upgraded software, incorporating high manoeuveres at multiple points and steep dive from high altitude was flight tested successfully at the Launch Complex III at the Integrated Test Range, Chandipur. All telemetry, tracking stations including naval ships near terminal point confirmed mission success. The launch was executed from a mobile autonomous launcher by the trained army personnel. DRDO scientists, were present to see the supersonic maneuvers of the missile in the real time display. The flight was witnessed by high ranking officials of the Army, who expressed their desire in having such high potential weapon system in the Army. Dr. A Sivathannu Pillai, CCR&D (DRDO) & CEO, MD Brahmos Aerospace described the successful mission as a "text book launch".

DRIVEN BY INNOVATION

Vayu interview with Major General Ilan Biran, Chairman of Rafael

Major General (Ret.) Ilan Biran, Rafael's Chairman of the board of directors talked with *Vayu* on the Group's strategic growth in domestic operations and international partnerships, including those with India.

VAYU: How do you see the Indo-Israeli Defence Relations evolve?

On the bilateral level, I have been involved with Israel-India defence relations for the past 15 years. Our first test was in 1999 when we opened our doors to India, during the Kargil War; 'a friend in need is a friend indeed' was our motto. Back then our mutual relations passed a major test, as India realised that Israel could be trusted during the most critical time.

Then as the Director General of the Ministry of Defence and now, as Chairman of Israel's leading defence R&D Company, I have encouraged indigenous, mutual thrust and unfettered exchange of professional and technological ideas for mutual benefits of the two countries. On the personal level, Rafael has established close personal relations with their Indian peers, especially among programme managers and leaders in parallel fields of activity, a familiarity that opens the way for future cooperation.

At Rafael we respect India as a prime customer for every major programme and consider India, along with the USA and Europe among the markets ready to absorb our highest, most advanced solutions.

VAYU: In the past India's restricted access to some markets, like the U.S, helped Israel in marketing its products here. With India becoming one of the world's largest arms importer, competition has increased and is Rafael losing ground?

Competition is growing but we are not intimidated by it, as the evolving competition opens more opportunities, from which India can choose from, where they can realise the quality, reliability, flexibility and fair trade we bring to the table. We promise our best products at top quality - and unlike other countries - with no political margin, since our mutual cooperation is managed at low key. Israel is a small country and we do not demand anything from India. Our defence ministry enables us to offer India the best, most advanced technology and, unlike other countries, politicians are not involved in this process.

VAYU: What are your reactions to India's growing 'Buy Local' and 'Technology Transfer' requirements?

We are fully aware of the new Defence Procurement Procedure (DPP) and are studying it. We hope it will pave the way to open more opportunities and expand partnerships, offering better quality of cooperation in the future. While we made our position clear, that foreign ownership of 26% limits such potential cooperation, we oblige to India's directives and will meet them to the full extent. They are the customer and they have the right to define what they want and how they want it.

This requirement is not endemic to India; realising the world has moved from 'buy' to 'make', we are addressing this trend by cooperating with major market players in each of our strategic markets. In the USA we partnered with several leading defence contractors such as Northrop Grumman (producing electro-optical pods), General Dynamics (armour protection) and Raytheon (missiles). In Europe we are working with Rheinmetall Defence and Diehl, on the local production of tactical missiles. We expect establishing similar partnerships with leading companies in India, to seek mutually beneficial solutions in answer to India's specific requirements.

VAYU: Another challenge for foreign companies is India's Technological Transfer demands. How do you plan to deal with these requirements?

We expect some of these programmes to evolve through our cooperation with India's Defence Research & Development Organisation (DRDO) and the military services.

DRDO is the leading authority for defence technology in India and, together with Rafael as its Israeli peer, both parties can benefit exceedingly from such cooperation, developing advanced, high-quality and practical solutions to address India's evolving threats. Such cooperation could also provide the basis for technology transfer, required by the current DPP.

VAYU: Rafael has grown dramatically in recent years, what are the factors behind this growth and how do you plan to sustain this?

As Israel's centre of excellence in research and development (R&D) for defence systems for more than two generations, Rafael is meeting these challenges by maintaining the highest skilled personnel force available in the country, mastering all technological and scientific fields critical for its unique developments. We attract the best, most experienced talents in the field of engineering and technological domain critical for our activities; these people are not only talented, skilled team players, but also highly motivated, since they know their work is critical for their nations' security.

Driven by innovation, R&D and addressing specific and unique requirements in timely and comprehensive ways, Rafael established itself as a 'boutique' rather than mass-production industrialist company, meeting specific customer requirements with rapid development, small production series,

endorsing customer participation in local production, sustainment and support, as an inherent business philosophy.

In Rafael we focus mainly on the development of innovative solutions, production of core sub-systems and final assembly of the systems; the rest of the production we outsource to sub-contractors and partners in Israel and abroad. This strategy helps Rafael to grow quickly and efficiently, without expanding or eroding the quality of our personnel. It is also well positioned to obtain export contracts, addressing local production mandated by the customer. As I mentioned before, our international growth is based on partnership with local companies in the leading markets, such as in India, the USA and Europe.

VAYU: Concerning Aero-India 2011, what is Rafael's main focus there?

We have recently increased our cooperation with India in air superiority and air-defence, and our activities now span over air, land and naval systems. At Aero India 2011 we are showing the Spyder air defence systems designed to protect ground facilities and our air/air missiles for the latest fighter aircraft. Addressing new and future requirements we are promoting some of our latest, most innovative solutions, such as the *Iron Dome* active defence system, protecting against rockets, mortars and artillery. As our next generation air defense system *David's Sling* is matured, we shall be able to promote it here as the next generation 'modular' system, capable in handling multiple endo-atmospheric threats from different platforms. This groundbreaking missile will be able to defeat many different threats, ranging from ballistic missile, through long range rockets, cruise missiles, unmanned systems, to aircraft, or precision-guided weapons, all with a single type of weapon – offering significant advantage in operational terms, economy of force and logistical support.

Other proposals by Rafael include the Spice air/ground weapons, currently in production for the Israel Air Force, as well as Spike family missiles, operated by various platforms, from the dismounted team to vehicles, to naval vessels and helicopters, capable of engaging high value targets from a distance of four kilometers to much further.

We also propose advanced digital wireless communications technologies, offering protected, secure communication exchange of voice, data and video across various domains, including air, land and naval platforms. Another state-of-the-art system offered by Rafael, is the advanced multi-intelligence centre called *Imilite*, processing data from multiple imaging sources and displaying it as for analysts as processed, fused intelligence, ready for 'consumption' by decision makers. Integration of aerostat-borne sensors is yet another field of activity where Rafael acquired considerable experience and know-how through many years of developing and supporting operational systems.

ITT and wireless networking systems

With more than 600,000 tactical communications systems in use by more than 35 countries, ITT is the world leader in wireless networking systems for tactical military and government systems. ITT is the largest international provider of military VHF radios, including the Single Channel Ground and Airborne Radio System (SINCGARS) sold in both domestic and foreign markets around the globe and Bowman-produced for the United Kingdom Ministry of Defence.

At Aero India 2011, ITT will showcase a variety of military communications solutions that stretch well beyond the SINCGARS and Bowman systems. These will include the On-the-Move(OTM) Satellite Communications (SATCOM) system Global Network-on-the-Move Active Distribution (GNOMAD), and tactical networking radios such as SpearNet and the High Capacity Data Radio (HCDR). ITT will also feature a Hands-free Audio-Video Capture and Transcribing system at the show.

"At ITT, we saw the need to provide a tactically smart, reliable, affordable and easy-to-use (SATCOM) system to extend the battlefield communications network to the tactical edge," said Ross Osborne, Business Development Manager for ITT Communications Systems.

The GNOMAD communication system is a ruggedised system consisting of a low-profile satellite antenna and a baseband modular chassis. It can be installed on various vehicle types, including military HMMWVs, MRAPs, MATVs, and Stryker vehicles, as well as commercial SUVs. The GNOMAD system provides broadband, on-the-move, satellite connectivity through a Ku-band satellite system providing 512 Kb/s up and up to 2Mb/s down to the vehicle in motion at vehicle speeds up to 120 miles per hour. Additionally, the open architecture nature and scalability of the base band package assures interoperability with existing communications infrastructure and the ability to expand capabilities to meet ever-changing mission needs. ITT can provide the system configured with a variety of n-the-move capable modems to meet customer needs. These modems include Hughes, COMTECH, iDirect, and Viasat/Linkway. As a combat-proven and reliable communications system, GNOMAD extends critical network connectivity to the lowest possible echelon on the battlefield. "GNOMAD is ideal in mountainous terrain in places such as Afghanistan or remote locations like the far-western regions of India, where traditional line-of-sight tactical communications radio capabilities are limited," said Osborne.

ITT's SpearNet Team Member radio will also be on display at Aero India. SpearNet is a wearable radio that provides networked communications to dismounted soldiers. SpearNet is a MANET radio which enables the soldier to extend their range of voice and data over a large network of radios. MANET is autonomously with the soldier. With a data rate of more than one megabit per second, SpearNet is also able to transfer real-time Triple Play (voice, video and data). ITT highlights the use of SpearNet in non-line-of-sight combat environments such as subways, buildings, and ship-boardings. "Several international customers have given positive reviews regarding this advanced system, which provides self-forming, self-healing ad-hoc networking with multi-hop routing of both voice and data capability," Osborne said.

Rounding off ITT's communications presence at Aero India is the HCDR, a UHF MANET data communications system. This ad hoc system creates a self-forming, self-healing, self-managing adaptive mobile network. HCDR has no fixed infrastructure, making the data network always available and mobile. This battle-proven radio provides high-speed data information amongst and between maritime, ground forces and air support.

"HCDR is the only radio of its kind creating a communications backbone for messaging, internet and situation awareness supporting mission-critical on the move operations," said Osborne.

"ITT provides a tremendous capability when coupling SpearNet with HCDR and GNOMAD to the soldier; spanning the entire battlespace."

Back from the cold : Viking's Twin Otter Series 400

In 1965, de Havilland Canada developed the DHC-6 Twin Otter aircraft, a high-winged, un-pressurised twin turbine engine-powered aircraft with fixed tricycle landing gear. Designed as a rugged Short Take Off and Landing (STOL) commuter, the Twin Otter was capable of carrying passengers and cargo to remote unimproved locations, including ski and water-based operations.

The aircraft were sold around the world to customers operating in the harshest environments, from sub-zero Antarctica to the hottest deserts of North Africa, from the mountainous regions in the Himalayas to the open waters of the Indian Ocean archipelagos. A testimony to its rugged construction and incredible STOL performance, the Twin Otter became the best selling 19 – seat passenger aircraft, and is still unmatched for its dependability and versatility.

The Twin Otter went through a production span of twenty-three years, before the line was officially shut down in 1988 after a total of 844 aircraft were delivered. The 'legacy fleet', as it is now known, has remained in active service carrying out jobs no other aircraft can do. In 2001, the Twin Otter was chosen for the emergency flight evacuation of a critical patient from the South Pole under extreme (-60oC) conditions.

Such ability to operate in any environment reliably and with minimal maintenance requirements, has kept the 'legacy fleet' at the forefront of niche markets around the world. It is often said that the only thing that can replace a Twin Otter is a Twin Otter, which explains the high demand in the market to keep the nearly 600 remaining aircraft in operation.

In 2005, Viking Air Limited, of Victoria, BC, Canada, purchased the Type Certificates for all the out-of-production de Havilland aircraft (DHC-1 through DHC-7), including the Twin Otter. After extensive market analysis, it was determined there was an overwhelming demand to bring the Twin Otter back into production, thus the Viking Series 400 Twin Otter Programme was announced in 2007.

The Series 400 Twin Otter will continue where the original de Havilland Series 300 Twin Otter left off, introducing upgraded Pratt & Whitney PT6A-34 engines, fully integrated Honeywell Primus Apex digital avionics suite, use of composite materials, other plus general modernisation. Approximately 800 changes have been incorporated to modify and improve upon the original production model.

Like its predecessor, the Series 400 Twin Otter will operate from remote and unimproved airfields owned to its robust design, equalised maintenance programmes, and dependability of the Pratt & Whitney engines, renowned for their reliability in varied operating environments.

Available with standard landing gear, optional straight or amphibious floats, skis or wheel skis, or intermediate flotation (Tundra) gear, with multiple interior configurations available, the Series 400 Twin Otter is a versatile aircraft that can be utilised for operations such as sub-arctic research, parachute training, regional commuters, and private use.

A military version of the Series 400, the Guardian 400, has also been developed. A versatile airframe that can be customised for unique use, the Guardian 400's low acquisition and operating costs and flexible architecture allows operators to select sensors and interior layouts to meet their specific mission profiles.

Viking has had much success, with a backlog estimated at over $200million in new aircraft sales to military, commercial, and private operators around the world. Recently announced was the order from the Vietnamese Navy.

The first all new Viking production Series 400 Twin Otter, Manufacturer Serial Number ("MSN") 845, was completed in early July 2010 and delivered to Zimex Aviation of Switzerland. Subsequent aircraft orders are expected throughout the next two years, creating a backlog with the next available delivery position in mid-2014.

Madhav Lokur, representative for Viking Air India, recalled that during 2010, several significant milestones were reached the receipt of Type Certification for the all new Series 400 Twin Otter and delivery of the first Viking production aircraft. The years ahead promise to be exciting for Viking with subsequent aircraft deliveries adding to the fleet of Twin Otter owners and operators worldwide.

THE INDIA – UNIQUE C-130J Super Hercules

IAF C-130J before its first flight.

Since this is India's first experience with the C-130, the package being provided by the U.S. government is "a complete solution". Along with the six aircraft, the package includes three years of initial support, training of aircrew and maintenance technicians, spares, ground support and test equipment, servicing carts, forklifts, loading vehicles, cargo pallets, and a team of technical specialists who will be based in India during the three year initial support period. Also included in the package is India-unique operational equipment designed to increase Special Operations capabilities. The C-130J Super Hercules will provide the Indian Air Force with modern and effective airlift to support a wide range of national requirements.

In keeping with IAF requirements, the US Government has offered a unique C-130J configuration modified for special mission roles. Equipped with an Infrared Detection Set (IDS), the aircraft will be able to perform precision low-level flying, airdrops and landings in blackout conditions. Self protection systems and other features are included to ensure aircraft survivability in hostile air defence environment. In addition the aircraft is equipped with air-to-air receiver refueling capability for extended range operations. Lockheed Martin will integrate this equipment and other capabilities into the IAF configuration as agreed between the governments.

The Indian Air Force's Super Hercules is the longer fuselage or "stretched" variant of the C 130J, similar to those being delivered to the U.S. Air Force. The IAF joins the growing number of other air forces with C-130J fleets including those of the United States, Australia, Canada, Demark, Italy, Norway and the United Kingdom. The C-130J carries eight 463L pallets, 97 medical litters, 24 CDS bundles, 128 combat troops and 92 paratroopers.

While the exterior looks very much like previous C-130s, the C-130J mission and propulsion systems have been completely redesigned. Primary features of the C-130J include a new digital avionics architecture and propulsion system, twin head-up pilot displays that are certified as primary flight instruments, and dual mission computers that automate many functions, allowing the aircraft to be operated by only two pilots and a loadmaster.

The net effect of these improvements is enhanced performance of the aircraft, and greater reliability of the systems and components. For instance, when compared with C 130E models, the C-130J provides 40-percent greater range, 40 percent higher cruising ceiling, 50-percent decrease in time-to-climb, 21 percent increase in maximum speed, and 41 percent decrease in maximum effort takeoff run.

Key to the C-130J's increased performance is its new propulsion system. Four Rolls Royce AE 2100D3 engines, each flat-rated at 4,591 shaft horsepower, generate 29 percent more thrust while being 15-percent more fuel efficient. The all composite six-blade Dowty Aerospace R391 propeller system is lighter and has fewer moving parts than previous Hercules propellers. Engines are precisely controlled by full authority digital electronic controls.

Front end of the new Hercules advanced technology is its modern flight station with multi-function, liquid crystal displays (LCD) for aircraft flight control, operating and navigation systems. In addition to four displays on the instrument panel, pilots use holographic head-up displays, approved as primary flight instruments, new among military transports. The displays are all compatible with night vision imaging systems, enabling the crew to operate the aircraft in areas where special missions dictate blackout conditions.

The dual mission computers manage and automate many of the functions formerly performed by the flight engineer and navigator. Aircraft systems are constantly monitored and crews are advised of status or malfunction as required. Some of the new systems of the aircraft managed by the mission computers include the full authority digital engine controls, the advisory caution and warning system, automatic thrust control, computerised maintenance recording, the electronic circuit breaker system, the enhanced stall warning system, the advanced digital map, and a state-of-the-art communication/ navigation suite.

The C-130J takes full advantage of the Global Positioning System and other highly reliable, automated navigation and route planning aides. This allows the cockpit crew to focus on the mission and on flying rather than on managing aircraft systems.

Lockheed Martin Aeronautical Systems began development of the C-130J in 1991, using corporate development funds. The first C-130J rolled off the assembly line in October 1995 which aircraft ordered by the United Kingdom's Royal Air Force, flew for the first time on 5 April, 1996. Following one of the most comprehensive flight tests programmes , the C-130J received type certification from the Federal Aviation Administration in August 1998, and deliveries began soon thereafter.

The Elbit Systems Targo HMA

Elbit Systems have recently unveiled its Targo Helmet-Mounted Avionics (HMA) Technology, which offers new and wider markets access to advanced helmet-mounted technologies.

TARGO.

With Targo, there are a range of capabilities tailored to specific aviator needs in a much wider spectrum of aircraft than ever before, and is easily integrated into an aircraft's avionics. Tango offers all the benefits of prior HMDs along with unprecedented avionics functionalities. Equipped with off-visor display for safest flying and click-on day, night and simulation modules, the Targo imbibes complete mission lifecycle technology, allowing pilots to plan, rehearse, fly and debrief missions using their personal helmets.

HMA was developed to meet the most demanding of missions, its cutting-edge technology delivering all mission-critical avionics and advanced features directly to the pilot, increasing safety levels and operational capabilities. Through unique flexible setups, from complete stand-alone, zero-installation versions to fully integrated configurations, Targo introduces a new realm of advanced, affordable avionics implemented directly into aviators' helmets.

Targo's capabilities and options are aimed at increasing pilot situational awareness and enhancing force coordination. Among Targo's advanced features are On Deck Networking to facilitate the sharing of mission-critical information between multiple users; Real-Time Mission Advisor with pop-up mission advisory information and on-demand database viewer, users can track mission tasks and accurately monitor performance; Line-Of-Sight (LOS) Sharing to allow users to share targets and points of interest and user friendly software tools to customise system interfaces, display symbols and more.

The systems are being marketed through Elbit Systems and its subsidiary, Vision Systems International, LLC (VSI), a joint venture with Rockwell Collins.

Avi Oil : created for self-reliance in Indian aviation

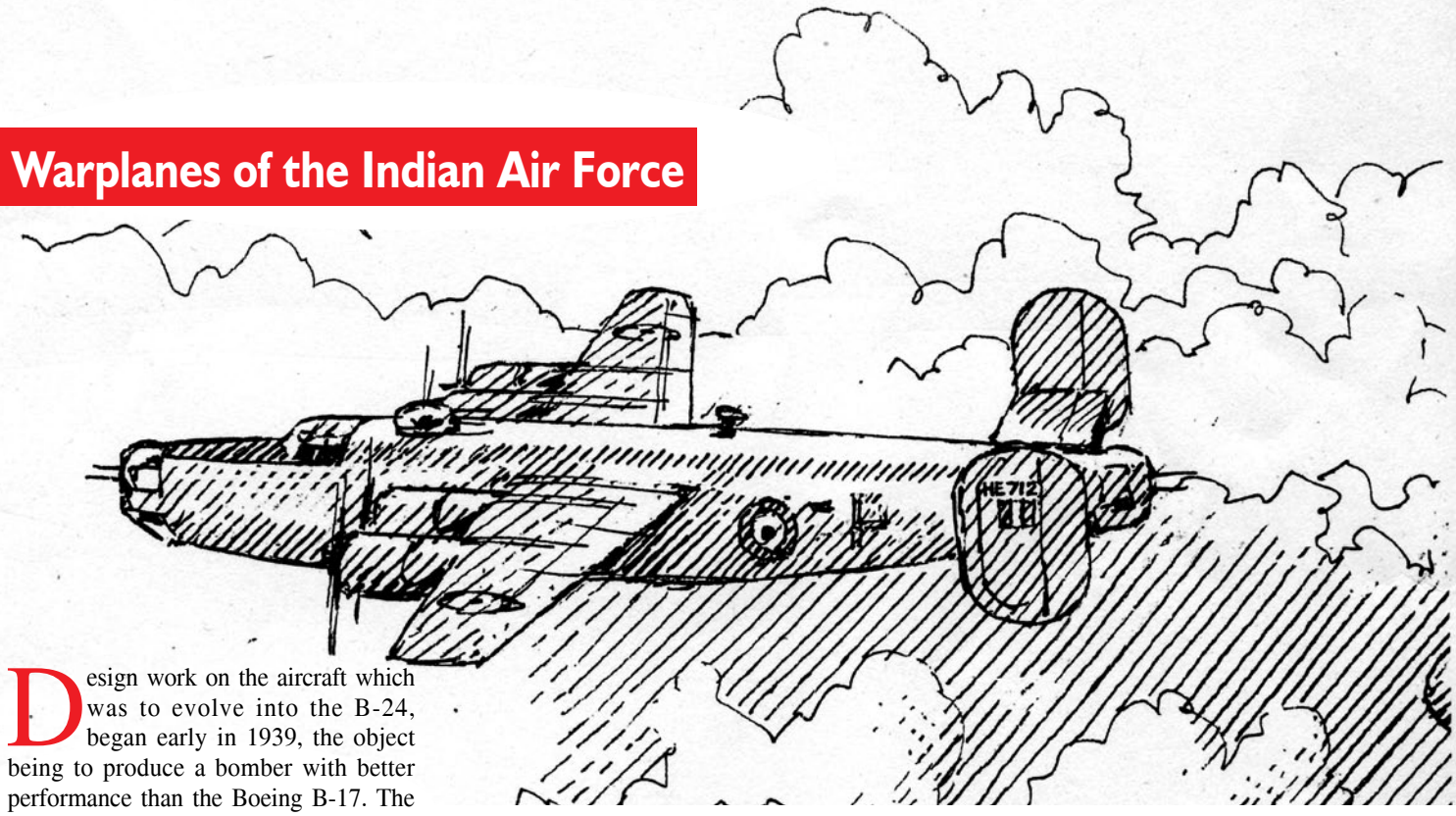
Avi-Oil India [P] Ltd. is a joint venture of Indian Oil Corporation Ltd., Balmer Lawrie and Co. Ltd. (both PSUs) and Nyco S.A. of France established for the indigenous production aviation and allied high performance lubricants to the Defence Services, Civil Aviation and other aircraft operators. Products include a wide range of lubricating oils, greases and specialities, mostly synthetic, designed to meet the stringent requirements of operation over a wide temperature range and often hostile environment.

Avi-Oil has been supplying aerolubes to the Indian Defence Services since 1994, critical products evaluated by the relevant approving agencies responsible for certification of aviation lubricants. The products of the company are 'Type Approved' by the Centre for Military Airworthiness and Certification (CEMILAC), and the company is registered with the Directorate General of Aeronautical Quality Assurance (DGAQA) Ministry of Defence, as an eligible manufacturer of aviation lubricants.

A full range of oils and greases required for all military aircraft operating in India are available including those for the Su -30MKI, IL-78 Flight Refuelling Aircraft, Hawk MK 132 Advanced Jet Trainer, Advanced Light Helicopter (Dhruv), the Light Combat Aircraft (Tejas) and the Embraer 135 BJ / Boeing BBJ the VVIP transport aircraft and the recently inducted AWACS by the Indian Air Force and the MiG-29 K inducted by the Navy.

In Civil Aviation, Avi-Oil offers the entire range of products for Airbus and Boeing fleets, including the synthetic lubricating oil approved to SAE AS5780 specification for the CFM56 and V2500 engines of the new generation Boeing 737 and Airbus A320 aircraft. A variety of piston-engine aircraft oils, greases and specialities are also available for use in smaller aircraft operated by flying clubs, pilot training schools and agricultural aviation. Avi-Oil is approved by the Director General of Civil Aviation (DGCA) under the CAR Series E Category D&E requirements.

For the helicopter industry, Avi-Oil has engine oils, hydraulic fluids, greases, protectives and specialities required by Eurocopter, Bell, MIL, Robinson, Schweitzer, Kamov and HAL for civil and military helicopters operating in India.



Consolidated B-24 Liberator

Design work on the aircraft which was to evolve into the B-24, began early in 1939, the object being to produce a bomber with better performance than the Boeing B-17. The B-24 was destined to serve with great distinction during World War II in many different roles.

The production pool, consisting of Consolidated's San Diego plant, Ford's Willow Run plant, North American's Dallas facility, the Douglas-operated Tulsa plant and Convair's Fort Worth plant, turned out 18,181 B-24 Liberators from June 1942 till June 1945, the largest number of one bomber ever built. The B-24J and B-24L (Liberators VI, VIII) were received by the R.A.F. under the lend-lease agreement and operated by heavy bomber squadrons of the Air Command, South East Asia from Eastern India during the years 1943-45.

In August 1947, the R.A.F. relinquished much of its hardware used in war against the Japanese, and included in the assortment was the huge Care & Maintenance Unit Depot at Cawnpore (Kanpur). Here, amongst the various trapping of the late air war, mouldered the remains of nearly a hundred B-24s. Some were mere shells, others had been cut into two; wings and tail assemblies were scattered about in lonely repose while a few were spared intact.

The Royal Indian Air Force, keen to establish a bomber force, had been offered Lancasters being disposed by the R.A.F. but it was decided to obtain fighter aircraft instead for the same money and, instead, reclaim some Liberators from within the country. Hindustan Aircraft Limited was given the job and parts began to arrive at this facility from Kanpur and then fromother parts of Asia as the story of the project spread across the land. At the time more than one U.S. and British adviser was sceptical but with the energy born of pride and necessity, take shape they did and by November 1948, the first six reconditioned B-24s stood ready for action. No.5 Squadronwas formed on the 17th of that month, and gradually made up its 16 aircraft UE as HAL turned out the Liberators and substituted their powerplants.

Most of the aircraft had been put together with whatever component was nearest at hand. Some originally had been painted the old U.S. Army olive drab while others had been left unpainted in keeping with U.S. policy of the latter war years. "When the first test crew took off in that modified job, it looked like such a patchwork thing that we could'nt believe it would stay in the air". Stay in the air it did and was soon joined by increasing numbers of B-24s. Later, in early 1950, No.6 Squadron was reformed, at Poona to receive B-24s and No. 16 Squadron established to provide back up training on the type.

During the Second World War R.A.F. Liberator VIs, their long range combined with a reasonable weapons bay, had roved over the Bay of Bengal and Indian Ocean seeking enemy submarines and hostile surface craft. Indian Air Force Liberators, fitted with an early model ASV15 radar in a retractable radome and bomb bays containing sunobuoys and depth charges, carried out maritime reconnaissance for nearly two decades after.

In 1957, Nos. 5 and 16 Squadrons were re-equipped with Canberra jet bombers, leaving No. 6 Squadron to continue with the Liberator. In the weeks preceding *Operation Vijay,* marking the end of Portuguese colonies in India, Liberators of No.6 Squadron from Poona and Jamnagar where intensively engaged in MR and Surveillance and during the brief action, dropped flares at night to assist in identification of coastal traffic at the approaches of Diu & Daman. The B-24s assisted mopping-up operations by the Army near Marmagao and on the 18th December 1961, dropped call-to-surrender leaflets all over Goa.

China reveals J-20 stealth fighter

In a clear signal that the Chinese aircraft industry have been steadily working towards development of a range of new generation combat aircraft, the much speculated and enigmatic Chinese J-XX stealth fighter, now officially identified as the J-20 (exotically referred to as 'Black Silk'), made its maiden flight at China's south western city of Chengdu on 11 January 2011.

The flight lasted 15 minutes, the J-20 escorted by chase J-10 aircraft, but the event was preceded for some weeks by tantalising pictures which had been carried by several Chinese websites. The very fact that these were not expunged from the websites reveals that the Chinese authorities meant the world to know of the existence of their new generation fighter. Even more pointed is the fact that the flight took place just hours before the US Secretary for Defence Robert Gates was meeting with the Chinese President Hu Jintao at the Great Hall of the People in Beijing (see separate article).

Apaches and Black Hawks for UAE

The United Arab Emirates (UAE) has requested a Foreign Military Sale (FMS) comprising 20 Boeing AH-64D Apache Longbow Block IIIs and 30 Lot 10 Block IIs. The Block IIs requested are US Army helicopters originally ordered in fiscal year 2000 which will be upgraded to Block III prior to delivery. If the sale proceeds, the UAE will become the second export customer for the Block III after Taiwan.

The deal was presented to the US Congress by the Defence Security Cooperation Agency (DSCA) on 3 November. Including a large support package, the sale is potentially worth $5 billion. The helicopters would be equipped with the Modernised Target Acquisition and Designation Slight / Modernised Pilot Night Vision Sensor and AN/APG-78 Fire Control Radar, and protected by the AN/ALQ-144(v)3 infrared jammer, AN/APR-39A(v)4 radar signal detecting set, AN/ALQ-136(v)5 radar jammer and AN/AAR-57(v)3/5 common missile warning system.

The UAE has acquired 30 AH-64As, delivered from October 1993, all of which have recently been upgraded to Apache Longbow Block II standard at Boeing's facility at Mesa, Arizona, under the terms of a 2006 contract. The primary weapon carried by the fleet is the AGM-114L-3 Hellfire II laser-guided air-to-ground missile.

Super Tucanos for Indonesia

Indonesia has selected the Embraer EMB-314 Super Tucano light attack turboprop to replace its Rockwell OV-10 Broncos, the Brazilian manufacturer to supply eight Super Tucanos, ground support equipment and an integrated logistics package to the *Tentara Nasional Indonesia Angkatan Udara* (Indonesian Air Force). The first aircraft will be handed over in 2012 and will undertake light attack, surveillance, air-to-air interception, and counter insurgency roles.

The Super Tucano was selected at the conclusion of a long-running competition, with Embraer winning against stiff competition from several other manufacturers, including Korea Aerospace Industries, whose KT-1 *Wong Bee* is already in service with the air force as a basic trainer. Indonesia plans to eventually acquire up to 16 Super Tucanos to equip two squadrons mostly for counter-insurgency campaigns.

Brazilian F-X2 fighter decision uncertain

Before stepping down from his office on 1 January 2011, Brazilian President Luiz Inacio Lula da Silva did not make a decision on the F-X2 multi-billion-dollar jet fighter purchase, leaving it to his successor, Dilma Rousseff, to decide on the issue. The purchase of 36 new fighters to replace Brazil's obsolete fighter fleet would cost between six billion and eight billion dollars and much more if options to expand the fleet to more than 100 aircraft are exercised. The competition was between the Dassault Rafale, the Boeing F/A-18 Super Hornet and Saab Gripen NG.

In 2010, Lula announced negotiations with France to buy the Rafale, but quickly backtracked under pressure from the Brazilian Air Force and the other two companies. The Brazilian media suggested the air force preferred the Gripen, prompting Lula to say he would make the final decision on political criteria, which seemed to favour France with which Brazil has a strategic pact, but that decision was put off several times. Former President Lula had earlier cancelled a previous fighter tender (F-X1) in 2003 to divert the money "for social programmes."

Former Jordanian F-5Es being upgraded for Brazil

The Brazilian Northrop F-5E Tiger modernisation programme is well underway with work recently starting on nine F-5Es and three F-5Fs purchased from the Royal Jordanian Air Force in 2008. The aircraft are among the last Brazil is upgrading as F-5EM/FMs by adding new avionics and systems and comprehensively overhauling the airframe.

EC725s delivered to Brazilian Armed Forces

Eurocopter's *Helicopteros do Brasil* (Helibras) subsidiary has delivered an initial three EC725s for Brazil's armed forces, marking a key milestone in the programme to supply 50 of these medium-sized, multi-role helicopters. These first three helicopters were provided in a standard configuration and will undergo final outfitting in Brazil. Eurocopter and Helibras pilots and technicians performed delivery flight tests, which were followed by acceptance evaluations carried out by Brazilian Armed Forces representatives, whose personnel have been in training since May 2010 to operate and maintain the EC725s.

Pakistan AF F-16C Block 52 deliveries continued

A further nine Lockheed Martin F-16C/D Block 52+ fighters were delivered to the Pakistan Air Force, comprising single-seat F-16Cs which flew to the PAF Base at Shahbaz, near Jacobabad on 30 October 2010. Brigadier General Michael Nagata, Deputy Commander, Office of Defence Representative in Pakistan, formally handed over the aircraft at Shahbaz on behalf of the US Government which were accepted on behalf of the Government of Pakistan by Air Marshal Mohammad Hassan, Deputy Chief of the Air Staff (Ops). Under the *Peace Drive I* Programme, a contract was signed with Lockheed Martin on 31 December 2007, covering 18 F-16C/D Block 52+s for the PAF, comprising 12 F-16Cs and six F-16Ds. The initial three aircraft to be delivered, one F-16C plus two F-16Ds had arrived at Shahbaz on 26 June 2010.

The second batch of aircraft had been due for delivery in August, but the widespread devastation caused by the floods in Pakistan during that month was threatening their base at Shahbaz, resulting in the decision to keep them in the US until floods subsided. The three that had already been delivered to Shahbaz were therefore temporarily flown out to PAF Base Samungli, Quetta, around mid-late August as a precaution and were flown on to Shahbaz later.

A further six aircraft (one F-16D plus five F-16Cs) later arrived at Shahbaz on 20 November 2010 and then officially handed over, all 18 of those ordered being scheduled to arrive in Pakistan by the year-end.

PAF at 'Falcon Air Meet 2010'

For two weeks from 19 October, an exercise *Falcon Air Meet* 2010 hosted by the Royal Jordanian Air Force took place at Muwaffaq Salti Air Base in Jordan. Participating were Mirage 5s of No.7 Squadron Pakistan Air Force, F-16E/F Desert Falcons from the United Arab Emirates Air Force, F-16C/Ds of the 55th Fighter Squadron, 20th Fighter Wing of the US Air Force, and assets from the US Navy's Carrier Air Wing 3 from the USS *Harry S Truman.*

Indonesia considering more F-16s

Indonesian Defence Ministry officials are considering a renewed offer from the US Government of the "donation" of 24 surplus F-16 Block 32s, the offer conditional on Indonesia paying for upgrade of these aircraft to Block 52 standard. It is also planned to modernise the ten existing *Tentara National Indonesia – Angkatan Udara* (TNI-AU – Indonesian Air Force) F-16A/B Block 15s to the same status and also possibly purchase six new production Block 52 F-16s.

The TNI-AU is also beginning the evaluation process for replacement of its FFA AS-202B primary trainers, flown by *Skadron Pendidkan* 101 (101 Flying Training Squadron) at Surakarta/Adisumarmo Air Base. Types being considered are the Aermacchi SF260TP, Grob G120TP and PAC CT-4G.

The Indonesian Army is seeking to purchase an initial batch of six medium utility helicopters for which the Government has allocated $65 million, which would later be followed by acquisition of a second batch of eight helicopters. No type selection has yet been made, but likely contenders are expected to include the AgustaWestland AW139, Bell 412EP and NHI NH90.

Pakistan Navy inducts four more Z-9ECs

A formal induction ceremony was held at Pakistan Navy Aviation Base PNS *Mehran* on 4 November 2010 for four new HAMC Z-9EC *Haitun* anti-submarine helicopters and a Hawker 850XP electronic warfare aircraft. In the presence of Chief of the Naval Staff, Admiral Nomain Bashir, the ceremony concluded with a flypast by the new helicopters which were acquired through a contract with China National Aero Technology Import and Export Corporation (CATIC) to join the three inducted in September 2010.

The type is flown by the PN's 222 Squadron, which was re-activated on 5 April 2009 and operates from the Navy's new F-22P frigates, also acquired from China. Previous reports had indicated that the total order was for six Z-9ECs, but the arrival of four additional helicopters indicates that this has been increased to seven.

The Hawker 850XP was delivered in August 2010, the aircraft has not yet taken up a military serial and still carries its US registration. The aircraft will reportedly return to the US for outfitting with its full mission systems fit, which will include sophisticated intelligence gathering equipment.

PLAAF 'August 1' Team J-10s debut in new colours

Chinese People's Liberation Army Force J-10AYs of the 'August 1' display team showed off their new colour scheme recently applied to the team's new aircraft. The team made its first public appearance with the J-10s in their new colours at Air Show China in Zhuhai, in the third week of November 2010.

Chinese bombers in long-range exercise

Taking part in an exercise *Peace Mission* during 9-25 September 2010 were four PLAAF H-6H medium bombers and two J-10 multi-role fighters which flew long distance to Kazakhstan to launch 'bombing-attacks'. *Peace Mission 2010* is the seventh joint exercise of this kind, involving 5,000 personnel from five of the six Shanghai Cooperation Organisation member

states which include China, Kazakhstan, Kyrgyzstan, Russia and Tajikistan. Uzbekistan did not take part in this exercise.

The simulated cross-border strikes were the first by the Chinese Air Force, according to Major General Meng Guoping of the PLAAF. The six aircraft were split into two missions, supported by an air early warning aircraft and refuelled by an aerial tanker before they crossed the Chinese border into Kazakhstan.

General Meng explained that the Chinese Air Force is trying to build an integrated air battle group encompassing early warning, command, long-distance bombing, escort and air refuelling aircraft. He also summarised a number of new characteristics of the *Peace Mission 2010* exercise, including information-based operations, field training exercises, coordinated command and control, combined actions, and diversified out of area support.

Bolivia seeks Iranian aircraft

The Bolivian President Evo Morales signed an agreement to purchase Iranian-made aircraft which followed his visit to Teheran in late October 2010. Bolivia is interested in the FACI *Fajr* F-3 basic trainer, the *Irgai* S-68 (a reverse engineered Pilatus PC-7 TurboTrainer) and the Iama (Hesa) IrAn-140 *Faraz,* the locally-produced version of the Antonov An-140, plus an unidentified four-seat helicopter type. All these are intended for the *Fuerza Aérea Boliviana* (FAB, Bolivian Air Force) although no details about quantities or delivery schedules have been released. In addition, Iranian technicians will travel to South America to help maintain FAB aircraft.

More F-15K 'Slam Eagles' for RoKAF

Boeing delivered three F-15K 'Slam Eagles' to the Republic of Korea Air Force (ROKAF) at Daegu Air Base in November 2010, the company having earlier delivered the first three of 21 F-15Ks it is producing under the *Next Fighter* II contract to the ROKAF in September 2010. The remaining 15 aircraft will be delivered through March 2012.

Six of the new F-15K 'Slam Eagles' are scheduled to participate in an advanced aerial combat training exercise at Nellis Air Force Base, Nevada, in late 2011. The F-15K is an advanced variant of the combat-proven F-15E. Equipped with the latest technological upgrades, it is "extremely capable, survivable and maintainable." The aircraft's service life is planned through 2040, with technology insertions and upgrades throughout its life cycle.

Naval Strike Missiles for Poland

Kongsberg Defence Systems has signed a contract with the Polish Ministry of Defence, the scope of the contract including Naval Strike Missiles (NSM) and logistics equipment. The agreement is an extension of the contract disclosed to the Oslo Stock Exchange on 30 December 2008.

Raytheon AESA radar for F-15C fighters

Raytheon has received a contract from Boeing for production of advanced APG-63(V)3 Active Electronically Scanned Array radars for the U.S. Air Force and the U.S. Air National Guard. The radars are intended to enhance the performance of already deployed F-15C aircraft and will replace the current mechanically scanned radar systems. "With its superior targeting and tracking capabilities, the APG-63(V)3 will enable aircrew to detect and identify targets well beyond the range of the existing systems."

MBDA delivers 600th Taurus KEPD 350

Taurus System GmbH (TSG), a subsidiary of LFK-Lenkflugkörpersysteme GmbH (MBDA Deutschland) and Saab Dynamics, has delivered its 600th missile to the German Federal Office of Defence Technology and Procurement (BWB).

The Taurus KEPD 350 is considered one of the "world's most modern long range standoff guided missile systems. Thanks to its Tri-Tec navigation system, which consists of a

GPS-supported inertial navigation, a radar altimeter and an imaging IR seeker head, the Taurus is designed for precision strike". The German Luftwaffe deploys the Taurus KEPD 350 precision standoff guided missile system on the Tornado IDS. The Spanish Air Force uses it to arm its EF-18 aircraft, for whom all missiles were delivered on schedule by August 2010. Future development enhancements to this system are possible in such areas as in-flight control, anti-ship operations, integration within a network enabled environment and integration onto the Eurofighter Typhoon.

Thailand orders more Gripens

The Royal Thai Air Force has ordered another six Gripen fighters and a Saab 340AEW worth approximately 2.2 billion SEK. The six Gripen aircraft are of the single-seat C version and the project duration is between 2010 -2013.

The order is a follow-up to an earlier order in 2008 when Thailand ordered six Gripens along with the Saab 340AEW aircraft. "The order strengthens the cooperation between Thailand and Sweden. It also serves as further proof of Saab's ability to deliver sophisticated integrated defence systems as well as strengthening international faith in the Gripen system," said Håkan Buskhe CEO of Saab.

Cassidian radar for German F125 frigates

Cassidian, the recently renamed defence and security division of EADS, is equipping the German Navy's new F125 stabilisation frigates with their newly developed TRS-4D/NR radar, which detects movements on the sea and in the air with previously unattainable precision. Cassidian has received an order for four naval radars and one land-based system from Blohm & Voss Naval GmbH, in Hamburg, Germany.

As per its name, the TRS-4D symbolises the step from the conventional system design of the TRS-3D into a "new dimension". The TRS-4D radar is based on a new aerial concept and the latest radar technology which, in comparison to conventional radar systems, enables completely new options for location and surveillance. For the new F125 frigates, each radar is installed with four fixed, i.e. non-rotating, aerial panels. The TRS-3D on the other hand works with a rotating aerial, using the technology of electronic beam scanning (E-Scan), which is deployed for both conventional, mechanically rotating aerials and immovably mounted radar aerial panels such as those used on the F125. From 2016, the four F125 frigates of the *Baden-Württemberg*-class should replace the F122 *Bremen*-class ships.

RAF's 7th C-17 Globemaster III

Boeing has delivered the seventh C-17 Globemaster III to the Royal Air Force during a ceremony at Boeing's final assembly

facility in Long Beach. The United Kingdom's fleet of C-17s have logged more than 60,000 flight hours, and supported humanitarian and disaster-relief missions to Pakistan, Haiti and Chile. Assigned to No.99 Squadron at RAF Brize Norton near Oxford, C-17s provide critical airlift capability for the nation's Joint Rapid Reaction Force. Brize Norton is the RAF's main operating base for strategic air transport and air-to-air refuelling.

SAAF's first Gripen pilots

The South African Air Force (SAAF) have introduced the first locally-qualified Saab Gripen fighter pilots during a solo flying event held at Air Force Base Makhado. The four pilots, three males and a first-ever SAAF female Gripen fighter pilot, successfully completed the type Operational Conversion Course (OCC).

The SAAF has stated that the "achievement is a milestone in the history of South Africa, the SANDF and the SAAF as this is the first OCC to be presented by local SAAF pilot instructors from No.2 Squadron". The South African Air Force had ordered 28 Saab Gripen C&D advanced fighters in 1999 as part of a "strategic defence package," along with 24 BAE Systems Hawk Mk.120 lead-in fighter trainers.

The first four *Project Ukhozi* two-seat SAAF Gripen Ds were delivered on 17 September 2008 during the opening ceremony of that year's Africa Aerospace and Defence exhibition. Gripen D deliveries were completed in July 2009 and the first two Gripen Cs arrived in South Africa in February 2010. The SAAF currently has nine D and six C-model aircraft. Delivery of the last aircraft is expected in 2012, when SAAF will have 26 of the type, having trimmed two from its original order.

'Modernised' C-130s for RSAF

ST Aerospace has re-delivered the first of 10 modernised C-130 Hercules transport aircraft to the Republic of Singapore Air Force (RSAF), equipped with a modernised avionics suite that significantly improves the operational readiness, despatch reliability and operational efficiency of the aircraft. The new avionics suite is Global Air Traffic Management (GATM) compliant, and enables the aircraft to navigate safely, efficiently and accurately through CNS/ATM-regulated airspace worldwide, reducing the aircraft's response time in emergency humanitarian and disaster relief operations.

The modernisation programme also includes an indigenously-designed digital glass cockpit, featuring ergonomic man-machine interfaces that take into consideration the RSAF crew anthropology and human factors efficacy, resulting in reduced crew workload and operational fatigue. In addition, the first redelivered C-130B is upgraded with an Auxiliary Power Unit and Environmental Control System (APU / ECS) to provide commonality with the C-130H. With an improved air conditioning system and electrical power redundancy, this C-130B aircraft will be at par with RSAF's younger fleet of C-130H aircraft in terms of mission availability.

Pilatus PC-21s for Swiss Air Force

The Swiss Air Force is to expand its PC-21 Jet Pilot Training System (JEPAS) with a follow-up order for two further PC-21 turboprop training aircraft with logistics and engineering services, plus another debriefing system. The contract with Armasuisse, the Procurement and Technology Unit of the Swiss Federal Department of Defence, Civil Protection and Sport (DDPS), was signed in Stans on 17 December 2010 with delivery scheduled for the first half of 2012.

The Swiss Air Force took delivery of a fleet of six Pilatus PC-21 training aircraft in summer 2008 and Swiss Air Force pilots thereafter transfer directly to the F/A-18 fighter after basic training on the NCPC-7 and thorough instruction on the PC-21 Jet Pilot Training System (JEPAS). The PC-21's state-of-the-art cockpit is designed to simulate the functions of a modern combat aircraft which enables the operator to train pertinent skills at a very early stage of training.

As Oscar J. Schwenk, CEO and Chairman of the Board of Directors, commented, "The Swiss Air Force has achieved its main goal in purchasing the PC-21s, which is to train future military pilots to a higher standard in a shorter timeframe with the help of a high-performance, cost-effective training system designed to allow a direct transfer to the F/A-18 fighter jet. We are tremendously proud of the Swiss Air Force for their pioneering work! Our innovative PC-21 training system is creating a stir, and has also attracted the attention of numerous other air forces."

Super Hornets for RAAF

Boeing has delivered four new F/A-18F Super Hornets to the Royal Australian Air Force (RAAF) Base Amberley, expanding the RAAF's fleet of the advanced multirole fighters to 15. This has enabled the RAAF's achievement of Initial Operating Capability (IOC) by No.1 Squadron at Amberley. Boeing has delivered all 15 Super Hornets to Australia ahead of schedule.

The December arrival was the third Super Hornet delivery to the base during 2010. Three aircraft in the latest delivery were pre-wired for potential conversion to electronic attack capability during production at Boeing facilities in St. Louis; the remaining nine aircraft in the contract will be pre-wired in the same way before delivery to the RAAF's No. 6 Squadron.

The Australian government had announced in March 2007 that it would acquire 24 of the advanced Block II versions of the Super Hornet, all of which are equipped with the Raytheon-built APG-79 Active Electronically Scanned Array (AESA) radar.

Centennial T-6B Texan II for U.S. Navy

Hawker Beechcraft Corporation (HBC) has delivered a specially painted T-6B Texan II trainer aircraft to the United States Navy as part of the commemoration of the *Centennial of Naval Aviation*. The milestone aircraft, which will be based at Naval Air Station Whiting Field in Milton, Florida, was handed over to Rear Admiral William G. Sizemore, Chief of Naval Air Training on 7 December 2010, in a ceremony at HBC headquarters in Wichita.

Imminent deliveries of Airbus Military A330 MRTTs

The Airbus Military A330 Multi Role Tanker Transport is poised to be delivered to three different customers in 2011, following a flurry of activities which ended 2010, and with its position cemented as the only tanker offered in the US Air Force's KC-X tanker competition that is "real, certified, flying and refuelling."

In a major exercise with the Portuguese Air Force on three days in November, 25 F-16A/B pilots underwent air-to-air refuelling training, conducting more than 70 dry and wet contacts in different weapons configurations, thereafter expressing their satisfaction with the refuelling systems including the proven Aerial Refuelling Boom System (ARBS).

On 13 December 2010, the A330 MRTT Future Strategic Transport Aircraft (FSTA) for the UK's Royal Air Force successfully completed a series of dry contacts for the first time, performing simulated refuelling with a F-18 fighter using the FSTA's Fuselage Refuelling Unit. The Fuselage Refuelling Unit is the same that is offered on the EADS North America KC-45, the configuration of the A330 MRTT that is being offered to the U.S. Air Force.

Cochin

Italian Guardia di Finanza's second AW139

AgustaWestland has delivered a second AW139 medium twin helicopter to the Italian *Guardia di Finanza* (Customs and Border Patrol Service). The aircraft was accepted by Gen. Michele Adinolfi, *Guardia di Finanza* Chief of Staff and Gen. Daniele Caprino, Interregional Commander for North-East Italy, during an official ceremony held at AgustaWestland's Vergiate plant. The *Guardia di Finanza's* first AW139 was delivered in mid-2009.

The AW139s are being incorporated into the *Guardia di Finanza's* Aviation Service fleet as its new generation medium twin-engined helicopter, replacing older models. The AW139s will perform several missions including surveillance, reconnaissance, maritime patrol, law enforcement and homeland security.

EC 145s for Kazakhstan

The Kazakhstan Government has signed two agreements that will result in the creation of a joint company and delivery of 45 EC145s to the Kazakhstan military. The deals were signed in Paris during an official visit of the Kazakhstan President, Nursultan Abishuly Nazarbayev to France in October 2010.

A 50/50 joint venture will be established by Eurocopter and Kazakhstan Engineering to assemble and customise EC145s (as KH145s in Kazakhstan) as well as provide training and maintenance to support the helicopter in the new economic zone to be created by Belarus, Kazakhstan, Russia and other central Asian republics. The venture will be located in Astana and the first KH145s will be produced in 2011. Under the terms of a memorandum of understanding the new enterprise will assemble 45 EC145s within the next six years for the Kazakhstan Ministry of Defence, with the first six due to be delivered in 2011.

LEAP-X selected to power Airbus A320neo

Airbus has selected CFM International's advanced LEAP-X engine as part of its offering for the new A320neo (new engine option). The new airplane/engine combination could enter commercial service by spring 2016.

CFM launched the new LEAP-X engine as a totally new centreline engine in 2008 and the company held extensive discussions with potential customers around the globe, both airlines and leasing companies, to help define LEAP-X engine configuration to ensure that it meets their fundamental requirements of reliability, fuel efficiency, maintenance costs, and environmental performance.

CFM is currently receiving hardware for the build-up of eCore Demonstrator 2, which will begin testing in mid-2011. eCore Demo 2 will feature a 10-stage high-pressure compressor and two-stage high-pressure turbine, along with the lean burn, low emissions TAPS combustor. CFM will run a third core configuration in 2012, just prior to the first full LEAP-X1C engine test in early 2013.

7,000th CFM56-7B engine delivered to Boeing

CFM International has delivered the 7,000th CFM56-7B engine to Boeing Commercial Airplanes, paving the way for delivery of the 3,500th Next-Generation 737 aircraft. COPA Airlines will receive the engines on its Next-Generation 737 later this year.

As the Next-Generation 737 family continues its unprecedented success, the two companies are also celebrating another major milestone. On 31 October 1980, Boeing and CFM signed an agreement that would help change the face of commercial aviation: the CFM56-3 engine would become the exclusive powerplant for the Boeing 737-300/-400/-500 series of aircraft.

Boeing will shortly begin flight testing the advanced CFM56-7BE engine that will provide at least an additional 1 percent improvement in fuel burn as well as 4 percent lower maintenance costs (depending on the thrust rating). The aircraft is on schedule for certification and entry into service in third quarter of 2011.

CAE simulators for Airbus A350 XWB FFSs

CAE has signed a contract with Airbus to design and manufacture two CAE 7000 Series full-flight simulators (FFSs) for the Airbus A350 XWB, representing the world's first FFSs for the new long-range aircraft. In addition, CAE will develop six CAE SimfinityTM A350 XWB Airbus Procedures Trainers. CAE also signed contracts with Airbus to perform a range of upgrades on Airbus-owned FFSs and has received a contract from a North American customer to provide a Boeing 777 FFS. The contracts are valued at approximately C$70 million and bring the total FFS sales that CAE has announced to date in fiscal year 2011 to nine.

CAE has designed, developed and delivered the word's first full-flight simulators for more than 40 new aircraft representing 16 different original equipment manufacturers (OEMs). The first FFS for the A350 XWB is scheduled to be delivered in late 2012 to the Airbus Training Centre in Toulouse, France, where it will be used by Airbus to support aircraft training developments and certification, as well as for initial training of pilots for customers taking delivery of the aircraft. The A350 XWB FFSs will feature the industry-leading CAE TroposTM-6000 visual system and the CAE TrueTM Airport visual database update service, as well as a six-degree-of-freedom CAE TrueTM Electric Motion System. The CAE Simfinity Airbus Procedures Trainers (APT) provide a fully simulated Airbus aircraft cockpit using the same Level D simulation model as the FFS.

Cobham partners with Rockwell Collins on C919

Avionics manufacturer Rockwell Collins has selected Cobham as its partner for the Cabin Core System (CCS) on China's indigenous narrow body airliner, the Commercial Aircraft Corporation of China (COMAC) C919. Rockwell Collins' CCS will allow flight attendants to control all subsystems on the aircraft, including in-flight entertainment, passenger connectivity, heating/cooling and lighting. Cobham will provide the Distributed Passenger Address System (DPAS) as part of the Rockwell Collins CCS, which will be standard equipment on all C919s.

Airbus' 10,000th order with Virgin America's 60 A320 deal

Airbus announced its 10,000th order with a firm contract from Virgin America for 60 A320s, including 30 A320neo aircraft, the first firm order for the A320 new engine option, with Virgin America becoming launch customer for the A320neo. The 30 A320s will feature fuel-saving large wing tip devices called 'Sharklets,' although Virgin America has not yet announced its engine choice on the newly ordered A320s or the A320neo. Seating configuration on the aircraft will be the same as its existing A320 fleet (146-149 seats) in a two-class configuration.

New record deliveries for Airbus

Airbus has increased its production output for the ninth year in a row and achieved a new company record of 510 (2009: 498) commercial aircraft deliveries to 94 customers (of which 19 were new). Deliveries included 401 A320 Family aircraft, 91 A330/A340s and 18 A380s. From its military division, Airbus delivered 20 light and medium military and transport aircraft (CN235 and C295), exceeding the 2009 figure by four aircraft.

Airbus booked 644 commercial aircraft orders (574 net) in 2010. The value of the new orders surpassed US$84 billion gross (US$74 billion net) at list prices. This represents 51 per cent by units of the 2010 gross worldwide market share of aircraft beyond 100 seats (52 % net). Airbus won 21 new orders for its military aircraft (CN235 and C295).

The new commercial orders include 452 A320 Family aircraft, 160 A330/A340/A350 XWB Family aircraft and 32 new orders for the A380. At 2010 years end, Airbus' commercial order book backlog was 3,552 aircraft valued at over US$480 billion at list prices, or equalling six years of full production while the military backlog stood at 247 aircraft.

In 2010, Airbus launched the A320neo (new engine option), offering 15 per cent less fuel burn. This is equivalent to a saving of up to 3,600 tonnes of CO2 emissions per aircraft per year. The A350 XWB continued winning key strategic campaigns during 2010, boosting the total orders for the family to 583 and number of customers to 36 by year end. On the industrial side, 2010 saw the start of manufacturing of the first A350 XWB components and sub assemblies at section level. The systems test rig (Iron Bird) for the A350 XWB started operations in December.

Recaro Aircraft Seating sets new records

Recaro Aircraft Seating of Germany produced more than 10,000 seats worldwide in November 2010 and the company's international manufacturing network expects to set a new record for the year with a total of 70,000 units.

"The high production numbers are driven by the huge demand for Recaro economy class seats from international airlines. The development at our production site in Swiebodzin is remarkable," said Dr. Mark Hiller, Chief Operations Officer. "We want to maintain the current production volume at our main plant in Schwaebisch Hall where we launch our new seat programmes. We plan to gradually increase production capacity at our plants in Poland and the USA," continued Hiller. "We have started a third production line at our factory in Swiebodzin."

Bombardier business jets

Bombardier Aerospace has received firm orders for five midsize Learjet 85 and two large cabin Challenger 605 jets from multiple companies of the same group, for principal operation in Germany by Munich-based Jet Air Flug. The total value of the order is approximately US $155 million.

"Our strategy is clear: we want to combine the world's most advanced aircraft with the highest safety standards along with the world's best service. The Learjet 85 and Challenger 605 jets complement each other very well, offering the perfect range and cabin versatility. Adding these new jets to our fleet will ensure we meet the needs of our very strong existing customer base in Western Europe and Russia as well as supporting our ambitious plans into Africa," said Patrick Raftery, Group CEO, Jet Air.

F-35 JSF achieves flight test target

On 9 December 2010, the Lockheed Martin F-35 Lightning II programme reached its 2010 goal of 394 test flights as established by the Joint Strike Fighter Programme Office and Lockheed Martin. Since first flight of the F-35 on 15 December 2006, the programme has logged a total of 531 flights, expanding the performance envelope of the three F-35 variants and testing the mission systems.

"While we are still behind on our overall STOVL variant testing, we are working through a plan to get this back on track," stated J.D. McFarlan, Lockheed Martin Vice President of F-35 Test and Verification.

Both the F-35B short takeoff/vertical landing (STOVL) and the F-35A conventional takeoff and landing (CTOL) variants have exceeded their monthly flight targets, but the F-35C carrier variant (CV) was just two flights short of its plan.

US Air Force examines J-STARS Options

A Goodrich MS-177 (previously SYERS-3) very high-resolution digital camera has been tested by the US Air Force onboard the Northrop Grumman E-8C Joint Surveillance Target Attack Radar System (J-STARS) testbed (T-3) during August 2010. Linked to the aircraft's navigation system to provide precise location information, the camera allows the mission crew in the aircraft to visibly identify vehicles tracked by its AN/APY-7 radar. T-3 has completed four test flights with the sensor onboard.

The MS-177 has been developed from the Senior Year Electro-Optical Reconnaissance System (SYERS) operated by the Lockheed US-fleet. It has not been decided if the 1300 lb (591 kg) MS-177 will be introduced on the J-STARS fleet or on another platform. Plans to replace the AN/APY-7 of the E-8C with the Multi-Platform Radar Technology Insertion Programme

(MR-RTIP) radar are on hold and an analysis of alternatives is being conducted by the US Air Force about the future of its battlefield surveillance capabilities. Northrop Grumman now proposes to install an upgraded AN/APY-7 with additional check fairings on the E-8C, as well as continuing to replace the existing Pratt & Whitney TF33-PW-102C engines with newer JT8D-219s, at a cost of less than $3 billion. Installation of the MP-RTIP and other upgrades previously put forward would have cost an excess of $5 billion.

Airbus wins large Chinese orders

Li Hai, President of China Aviation Supplies Holding Company (CAS) and Tom Enders, President and Chief Executive Officer (CEO) of Airbus, signed a deal covering the purchase of 102 airliners on 4 November at the Elysée Palace in Paris. The ceremony was undertaken in the presence of the Chinese President Hu Jintao; the French President Nicolas Sarkozy; the UK Minister of Industry Mark Prisk and Louis Gallois CEO of EADS.

The 102 aircraft comprise 66 new-build that include 50 A320 family aircraft, six A330s and ten A350XWB, plus 36 previously announced A330s. Details of the variants to be acquired, the delivery schedule and the airliner's ultimate operators have not been released, but the aircraft are believed to be destined for Air China, China Eastern and China Southern. It has been confirmed that six A330s and 30 A320 family aircraft are destined for China Southern, as details of the $3.4 billion contract were posted on the Hong Kong stock market on 4 November 2010.

Meanwhile, Hong Kong Airlines signed a firm order for seven Airbus A330-200s and three A330-300s on 13 October, confirming a deal (originally for ten A330-200s) announced at the Farnborough International Air Show in July 2010. The airliners will be handed over from 2012. At the same time the carrier confirmed it would convert existing orders for 15 A330-200 into A350XWBs, which will be handed over from 2018.

Lightweight CASSIDIAN transponder

The European Aviation Safety Agency (EASA) has certified Cassidian's newly developed LTR 400 family of transponders to the latest standards which includes both civil as well as military applications for the equipment. The very low weight equipment, which is suitable for the identification of military aircraft as well as for use in civil air traffic control, is amongst the first in Europe to achieve this platform-independent approval.

At 2.8 kilograms, the LTR 400 is currently the smallest and lightest transponder worldwide, which can be used without any restrictions for both civilian air traffic control and military applications to identify friendly units. This unit operates to the latest civilian air traffic control standard, Mode S "Enhanced Surveillance". Together with the encryption and decryption computers from Cassidian, it can also be used in all currently

widespread military modes. Owing to its low weight, the LTR 400-A is particularly suitable for use on board helicopters and unmanned aerial vehicles. This equipment has already been ordered to equip Eurocopter's EC 635 helicopter.

Aster intercept of tactical ballistic missile

Within framework of the FSAF development programme whose aim is to provide the SAMP/T system with an anti-tactical ballistic missile defence capability, EUROSAM has carried out a system firing at the *Direction Générale de l'Armement* (DGA EM) test range located in Biscarrosse (south western France). The target used for the firing was representative of a medium-range ballistic missile. All successive phases of the operational engagement of a ballistic missile ran nominally, from target designation transmission to the SAMP/T firing control system, target acquisition by the ARABEL radar, engagement sequence and firing decision, ASTER missile flight sequence and guidance through to target interception.

The SAMP/T system comprises the Engagement Module, the ARABEL Radar and Identification Module with its Electrical Generation Unit, a Vertical Launch Unit and the ASTER 30 Block1 Missile.

LEAP-X1C launched for China's C919

In mid-November 2010, Commercial Aircraft Corporation of China (COMAC) and CFM International launched the LEAP-X1C-powered C919. Air China, China Eastern, China Southern, Hainan Airlines, CDB Leasing Company, and GE Capital Aviation Services (GECAS) have ordered a combined total of 100 new aircraft with first deliveries scheduled for 2016.

COMAC selected CFM's advanced new LEAP-X engine as the sole western powerplant for the C919 in December 2009. COMAC has forecasted global sales of more than

2,000 C919 aircraft over the 20 years following entry into service. The two companies are nearing the completion of the joint definition phase and CFM is on schedule to freeze the LEAP-X design by the end of 2011 with the first full LEAP-X engine to go on test in early 2013. COMAC has opted for a complete Integrated Propulsion System (IPS) for the C919. CFM will provide the engine and, in partnership with Nexcelle*, the nacelle and thrust reverser to deliver a complete IPS solution to COMAC.

Cobham 'Fifth Gen' Refuelling Pod

Cobham's latest 'fifth generation' 905E Air-to-Air Refuelling (AAR) pod has been certified as part of the Airbus A330 Multi Role Tanker Transport (MRTT), which achieved military certification ahead of the planned first deliveries to the Royal Australian Air force.

Each Australian MRTT carries two 905E pods, one on each under wing station and individually capable of delivering fuel at 420 US gallons per minute. The pods features the latest version of Cobham's electric hose reel drive system and state of the art digital control and monitoring system, also fitted with Cobham's new high-speed variable drag drogue, which is key to meeting the extended aerial refuelling speed range of 180 knots to 325 knots (330km/h to 600km/h). This enables a single tanker to support a variety of aircraft from the Boeing V-22 Osprey to the latest generation fast jets such as the Lockheed Martin F-35 Lightning II Joint Strike Fighter.

First Italian Air Force T-346A trainers

Alenia Aermacchi has unveiled the first two M-346 advanced trainers from the first batch of six aircraft for the Italian Air Force, at its Venegono Superiore factory. The first two T-346As will be delivered to the Experimental Flying Unit at Pratica di Mare Air Force Base, near Rome, where they will undergo operational evaluation testing. During 2011 the Italian Air Force will receive the other four aircraft, becoming the world's first air force equipped with a new advanced training line based on the M-346, the most modern trainer currently available to train military pilots destined to fly the latest 4th and 5th generation fighters.

This marks the beginning of a new phase for the M-346. The new highly automated production line is already working on the other four Italian Air Force aircraft and has launched production of the 12 trainers ordered by the Republic of Singapore Air Force.

First NH90 TTH for Spain

Eurocopter has conducted maiden flight of Spain's NH90 TTH tactical transport helicopter at its Marignane facility in France. A multidisciplinary team from Eurocopter Espana contributed to this Spanish NH90 programme milestone, which involved the first NH90 equipped with GE CT7-8F5 engines. The helicopter will be transferred to Eurocopter's Albacete, Spain facility in 2011 to continue with development flight tests leading to its full qualification by the Spanish Ministry of Defence. Deliveries of NH90 TTHs for the Spanish Armed Forces are scheduled to begin in 2012.

Fourth Airbus Military A400M first flight

The fourth Airbus Military A400M military airlifter has made its first flight, marking culmination of a highly successful year which also saw the fleet of Grizzly development aircraft complete just over 1,000 hours flight-time and 300 flights. Known as Grizzly 4, the aircraft took off from Seville in Spain with a weight of 130 tonnes for a five hour and ten minutes flight.

Experimental Test Pilot Klaus-Dietrich Flade captained the flight, supported by Experimental Test Pilot Christophe Cail. The crew also included Test Flight Engineers Jose Aragon-Gomez and Bruno Bigand and Flight Test Engineers Jose Casado-Corpas as also Catherine Schneider, the last named being the first female Flight Test Engineer and test crew member to participate in an A400M first flight.

Following the A400M's maiden flight on 11 December 2009, Grizzly 2 and Grizzly 3 made their first flights in respectively April and July 2010 and carried out "outstanding demonstrations of the A400M's handling qualities" at the Berlin and Farnborough air shows.

Raytheon's SLAMRAAM test firing

Raytheon Company's SLAMRAAM (Surface Launched Advanced Medium Range Air-to-Air Missile) system successfully participated in a second ballistic test vehicle firing at Eglin Air Force Base, Florida. This is the second test firing of AMRAAM missiles from the new Family of Medium Tactical Vehicle (FMTV) platform.

The primary objective of this second ballistic test vehicle firing was to collect environmental data to characterise missile launch effects on the FMTV platform. These data provide input to engineering level assessments in support of system fielding requirements. In conjunction with the August 2010 test, the ballistic test vehicle firings were completed to verify that all system components have been successfully transitioned onto the new platform.

SLAMRAAM is a versatile, state-of-the-art air defence system that can counter current and emerging cruise missile threats and a wide range of advanced aircraft threats. This affordable adaptation of the AMRAAM to meet emerging needs provides a system of highly mobile battlefield elements networked and geographically distributed to provide integrated fire control capability against airborne threats.

Javelin fired from Stryker IFV

The Raytheon-Lockheed Martin Javelin Joint Venture reached a major milestone with the first Javelin missile firings from a Common Remote Operations Weapon Station II. The station was mounted on a Stryker Infantry Fighting Vehicle (IFV) in a near-tactical configuration. Three missiles impacted their targets at 500 and 1,000 meters (1,640 and 3,280 feet) downrange, confirming the successful integration of the Javelin into the CROWS II. The Javelin vehicle launch box, fire control unit and remote weapon system communicated effectively, resulting in an optimal firing of the missiles.

"The integration of the Javelin Weapon System with the Stryker IFV will give a precision fire capability that is organic and immediately available to the warfighter," said Duane Gooden, programme director of Raytheon's Javelin program and president of the Javelin Joint Venture. "This enables soldiers to stay protected inside the Stryker while still employing Javelin against a broad array of targets." The Stryker IFV armoured personal carrier has been used by the U.S. Army in Iraq and Afghanistan since 2003.

Electronica S.p.A.'s counter measures

The Italian Air Force (IAF) has selected the ELT/572 DIRCM (Directional InfraRed Countermeasures) by Elettronica S.p.A. for the protection of its platforms, which include the C-27J, C-130 and EH-101, being the first European Air Force to equip its platforms with such an innovative DIRCM system based on state-of-the-art technology. The contract would be fulfilled in about 3 years at a value of 25.4 million Euros with the first system deliveries scheduled at the end of 2013. The selected system is a dual-turret configuration ensuring a full 360° defensive coverage of the airborne platform against the shoulder-launched MANPADS (that represent one of the highest priority threats to platform survivability during take-off and landing phases). The ELT/572 system is based on fibre laser innovative technology that affords considerable advantages in terms of high precision performances and easy on board installation.

ThalesRaytheonSystems for German air defence radar

ThalesRaytheonSystems (TRS), in collaboration with Thales Germany, has been selected by the German Federal Office for Defence Technology and Procurement to supply six Ground Master 400 (GM 400) long-range air defence radars for the *Aktives Radarrundsuchgerät für den Einsatzführungsdienst* (ARED) programme. The ARED contract, valued around €100 million ($140 million), was awarded during a signing ceremony in Koblenz attended by representatives from the German Federal Office for Defence Technology and Procurement.

ThalesRaytheonSystems and Thales Germany will work with local German companies, including SERCO GmbH located in Bonn and EADS Deutschland GmbH in Unterschleissheim, to replace the six Thales Medium-Power Radars (MPR) supplied in the late-1970s. TRS is contracted to supply the new radars by 2015.

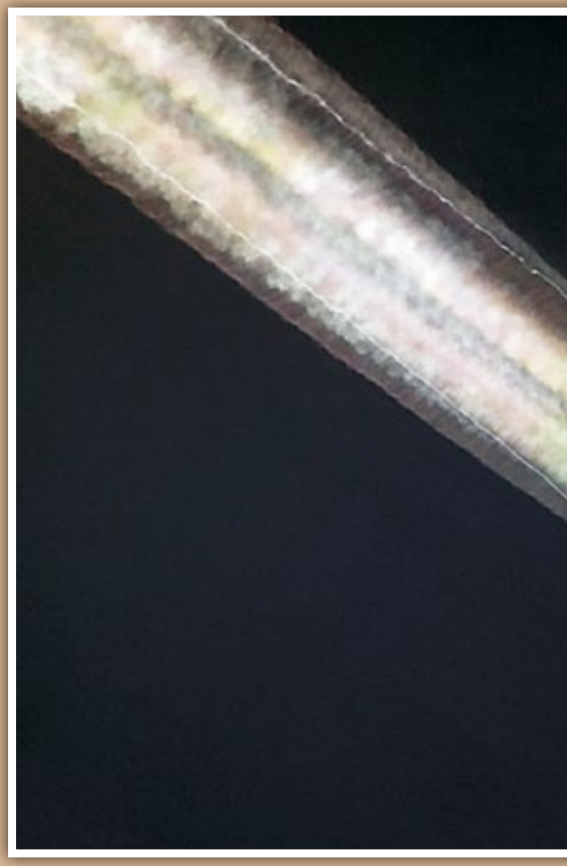
A Continuing Love Story

Some great aviation

Contrails of the Boeing 747.

Boeing 747 past a half Moon !!

Boeing 757 against a full Moon !!



shots!

A-7 Corsair IIs at Tucson Air Force Base, USA.

Airbus 340 rainbow contrail

F-15C Eagle in the fastest takeoff ever measured.

Airbus A330 landing at Amsterdam under dramatic skies.

Goliath : Russia's Antonov 225 - largest aircraft in the world.

Supersonic stakes : Last official flight of Concorde 101.

Concorde 101 parked nose down.
Look at stretch marks on skin!

F111C Aardvark torching it.

Mirror Image-for real : Sukhoi Su-27s close and tight.

B 52's in boneyard.

Dramatic approach : Boeing 757 at Gatwick.

FL 330, FL 340 - very dramatic - going opposite and 1000' separation!

Boeing 757 and wing vortex.

Whom are you kidding?

Boeing 767 wing vortex over clouds.

Contributed by Harindar Bedi (photo sources: internet)

TALE SPIN

Sweet & Sour Carrier

Talk of enterprise ! A UK-based Hong Kong chef-turned-entrepreneur, who is also a Zhuhai lawmaker, has made a bid for the Royal Navy's aircraft carrier HMS *Invincible* which is being sold off by Britain as part of Defence restructuring. Lam Kin-bong, who runs a chain of Chinese restaurants in the West Midlands of England, says his bid is purely commercial and has nothing to do with the military – he wants to use the 22,000 tonne carrier as a vast nightclub.

(From : South China Morning Post).

However, defence observers are not so convinced as this is exactly what happened when the Chinese bought the former Russian carrier *Varyag,* towed it to China and now – surprise, surprise, the enterprising Chinese Shipyards have resurrected this to become China's first operational aircraft carrier.

Raunchy videos on 'Enterprise'

In December 1971, the USS *Enterprise* sailed into the Bay of Bengal in a show of solidarity with the beleaguered Pak forces in erstwhile East Pakistan but the show was over and Bangladesh shortly was a reality. 40 years later, now under command of an officer who must have been in diapers then, the USS *Enterprise* is in the news for a completely different reason. Its Commander is being investigated for airing, on the ship's closed-circuit television, videos which are 'inappropriate'. In plain language, the raunchy videos were full of sexual innuendo, and shown to the 6000 crew members while the ship was on deployment supporting America's wars in Iraq and Afghanistan.

'Beam me down, Scotty' !

Sit still !

Alarmed at the increasing numbers of passengers who rush to open the overhead bins even as their airliner is still taxing, India's Directorate General of Civil Aviation have notified two new rules to constrain impatient folks. Under the new rules, such behaviour is punishable with imprisonment or fine or both.

'But we are like that only'.

We are optimists

Inspite of *La Belle France* having such a joyful image, according to a Gallup poll of 53 countries, the French are the world's saddest people, being champions of scepticism. On the other hand Indians are the greatest optimists, predicting that they will be increasingly prosperous in the times ahead. Even in war-torn countries like Afghanistan and Iraq, respondents appeared to be more confident of the future.

Is the West missing out on something?

Moving the Lord

Delhi's International Airport may boast one of the longest runways in the world (at 14,620 ft) but at least one third of it is not cleared for use because a statue of *Shiv Murty*, the lord of destruction is located such that the descending aircraft have to remain well above runway 29 before they are cleared for touchdown. The obvious solution is to shift the statue to a different location where it will not affect air traffic but this does not account for the fact that the statue is located at a spot which has acquired great sentimental significance over some time.

Lord, have mercy!

Not DIAL, but floodwaters over Rockhampton's runway 33 in Australia.

Art imitates life

This remarkable, virtual mirror image, is of a kite (the falcon kind) attacking a kite (of the paper kind) during the International Kite Festival in Ahmedabad on 10 January 2011. Kite-enthusiasts from 36 countries were participating in the annual festival but no one expected this stand off.

Photo: AP

Kiss me not !

An amorous pilot of an Indian airliner has been grounded, his flying license revoked after he allegedly kissed an airhostess in the cockpit during the long Delhi-Bangalore-Hyderabad-Cochin sector. The girl was too stunned to react at first but as the pilot tried it again, she 'escaped' to the passenger cabin.

Safety in numbers!

Afterburner

Bombardier

Raytheon (SAS)